JAN 19 1943

Compressed Air Magazine

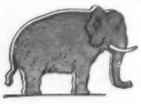
JANUARY 1943

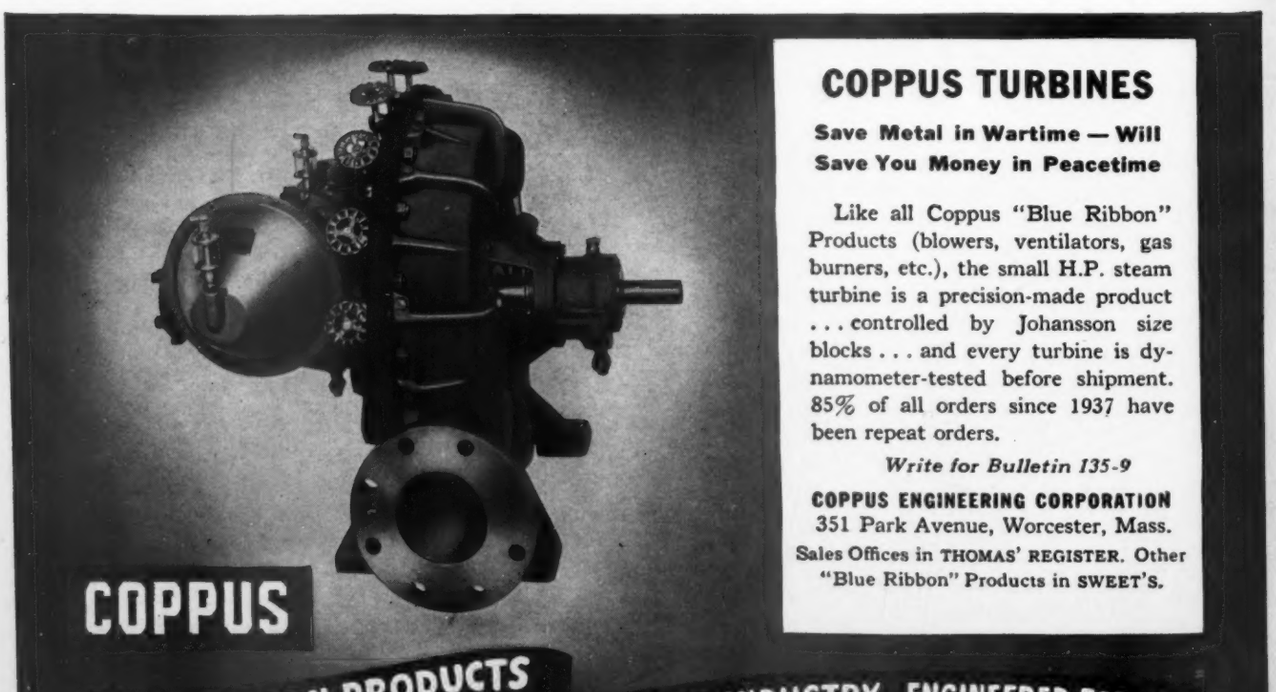
WOMAN GUNNER

Her husband is a Navy gunner. She stays home and runs a riveting "gun" in an airplane factory.

VOLUME 48 • NUMBER 1

NEW YORK • LONDON

A steam turbine needs a big frame to develop Elephant Power  . But if you need only Horsepower, a **COPPUS** Steam Turbine saves money and metal . Six sizes from 150 Horsepower down to fractional. Each smaller size has smaller frame requires less metal and is priced less . Each is a COPPUS Blue Ribbon Turbine so you get top quality while saving money and metal .



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ON THE COVER

AS OUR part in ushering in the New Year, we give you a new cover design. It is more modern and simpler than the old one, which served for eleven years, but retains two of the latter's foremost features: a large picture space and the characteristic red color. One advantage is that it provides more room for describing the illustration. This month's cover picture shows Mrs. Grace DeLong, an employee in one of the plants of the Douglas Aircraft Company, Inc. She is driving aluminum rivets in a section of a war plane. Women have proved themselves adept at this sort of work, which is made easier for them because of the availability of modern, lightweight pneumatic tools. The riveting hammer Mrs. DeLong is using is an Ingersoll-Rand Size AV-11. It weighs only 49 ounces and has an overall length of but slightly more than 6½ inches.

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IN THIS ISSUE

EVEN so small an article as the lead pencil is sacrificing something to help the war effort. The brass ferrule that formerly held the eraser has been replaced by paper or plastic, and the War Production Board says this substitution saves enough brass every year to make 126,000 machine-gun cartridges of .30 caliber. Erasers contain less rubber than formerly, and the finish imparted to the cedar wood is not so glossy owing to restrictions in the use of lacquers. Otherwise pencils retain their prewar construction. Our leading article describes the making of the Koh-I-Noor drawing pencil which was once obtained only from Europe but is now being turned out in a New Jersey factory.

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THERE are many ways of making a living. Shorty Liston makes his by catching wild horses in New Mexico. Carey Holbrook tells how it is done and paints a word picture of Shorty.

•

ANOTHER of our occasional articles dealing with getting more service from important industrial machines and materials appears in this number. The subject is wire rope, which in these times might appropriately be called war rope.

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A GLIMPSE of gold mining in Nicaragua is given us by William J. Roberts in his description of the sinking of a shaft at La Luz Mines. Mr. Roberts is a shift boss on the job.

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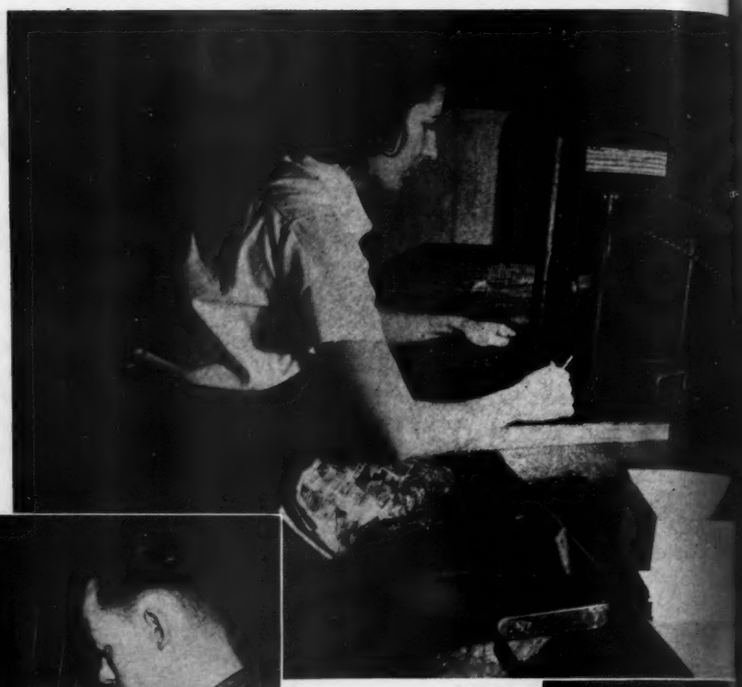
How Lead Pencils are Made

C. H. Vivian



MANUFACTURING OPERATIONS

1- The stack of cedar slats in the frame at the right is automatically fed to revolving knives that groove one side for leads and the reverse side with a single furrow to serve as a guide in a later operation. The grooved slats are mechanically stacked at the left. 2- Dexterous girls brush glue on the grooved sides of eight slats at one time, insert leads in the furrows of four of them, and then cover them with the remaining four slats. These are placed on the elevated conveyor at the right and pass to the station shown in picture No. 3. There a quantity of double slats is placed in a screw frame, subjected to 80 pounds pressure, and the screws are tightened to maintain it. 4- After being oven-dried for from 24 to 48 hours the pairs of slats go to a shaping machine, where they are cut apart into individual pencils by first passing over revolving knives and then under them. 5- The rough pencils are fed from a hopper to a moving carriage on which they pass beneath sandpaper pads that move longitudinally over the pencils. Hexagonal pencils are given one-sixth of a revolution between pads so that each face is sanded.

DRAFTSMEN, engineers, architects, and artists throughout the world have been familiar with Koh-I-Noor pencils for many years, but relatively few of them are probably aware of the fact that this well-known make that originally came only from Europe is now also being produced in the United States. That is why these pencils are still obtainable here and in all other countries that have not come under the domination of the Axis powers. During the first World War the supply of Koh-I-Noors from abroad was cut off, and they disappeared from the market as soon as domestic stocks had been exhausted. Had their manufacture not been begun in this country, the same condition would no doubt again prevail.

Koh-I-Noor drawing pencils were introduced in 1890 by L. & C. Hardtmuth, a concern that started business in 1790 in what is now Czechoslovakia. They were exhibited in 1893 at the World's Exposition in Chicago, where they were seen by Irving P. Favor, a partner in the firm of Favor, Ruhl & Company that handled artists' supplies. Impressed by the quality of the product, Mr. Favor sought and obtained the American agency for it, and his business progressed satisfactorily until hostilities enforced a 4-year interruption in imports. Immediately following the end of the war, Mr. Favor endeavored to reëstablish his business and, accordingly, organized a selling corporation under the name of Koh-I-Noor Pencil Company, Inc. That company, which was incorporated in 1919, has continued to function and is in active operation today selling the products of the Bloomsbury factory throughout the Western Hemisphere.

Although domestic pencil manufacturers had brought out high-grade drawing pencils during the World War period, the Koh-I-Noor's prestige enabled it to regain a fair share of its markets when shipments from abroad were resumed. Mr. Favor continued to direct the sales in this country for some years and was then succeeded by his son, Irving P. Favor, Jr. The latter came to the conclusion around 1936 that war would again flare up in Europe before long and took steps to establish manufacturing facilities here. A factory was

earth by the uprooting of a large oak tree during a storm in 1565. A native found it, noticed its unusual properties, and told his neighbors about it. Soon all were excited, and word of the strange new substance spread rapidly, even to the continent. Before its present name was adopted, it was called wad, black lead, black-cowke, and later plumbago. The superstitious country folk around Borrowdale ascribed curative powers to it, apothecaries kept it on their shelves for sale, and doctors prescribed it for certain ailments.

The Borrowdale deposits yielded large slabs of extraordinarily pure graphite. These were sawed into thin sheets and then into strips. One of the latter was glued between strips of wood to protect it in use, and thus the first lead pencil was made. One of the earliest applications of this graphite was that of branding sheep. The Borrowdale Mine gave England a monopoly in pencil making for many years, export of the graphite in any other form than pencils being prohibited. The mine was operated only often enough to furnish local manufacturers with the material they needed. Sometimes a six-weeks' run in twelve months would suffice; and in after years, when the pencil industry was depressed, graphite was produced only once every five or six years.

The mineral commanded a price of from 36 to 40 shillings a pound, and at times even higher. Consequently there was incentive for thievery, and it is reported that some of the villagers grew rich from such operations. During the reign of George II, Parliament passed an act making it a felony to "break into any mine or wad-hole of wad or black-cowke, commonly called black-lead, or steal any from them." It seems, though, that this was done not so much to protect the owners as to insure a sustained supply of graphite for casting bomb shells, shot, and cannon balls for the king's army. There is definite evidence here that graphite had already been applied as a facing to foundry molds, which is one of its present leading uses.

A graphite market was established in London, and the mineral was sold there at auction on the first Monday in each month. As the mine was in a remote section, it was necessary to provide armed guards to escort the wagons that made the deliveries. Precautions against theft also had to be taken at the mine. Houses were built over the entrances and were occupied by trusted stewards and workers. A change-room was provided for the miners, and there, upon coming off shift, they undressed and their clothes were searched to prevent them from carrying away any graphite. In an adjoining room the mineral was cleaned and assorted under guard.

In 1678 the mine was closed, being considered worked out. It was reopened in

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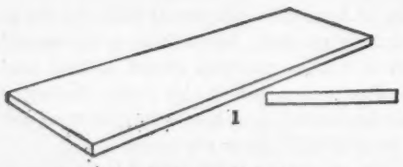
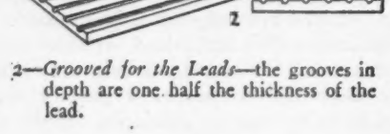
located in Bloomsbury, N. J., in 1938, and since that time most of the Koh-I-Noor pencils sold in the United States have been made there.

Before describing how the leads are produced, encased in wood, and finished for the market, it will be of interest to have a brief look at the history of lead pencils. They were made possible by the discovery of graphite, the peculiar greasy-feeling black mineral that derived its name from the Greek *graphein*, meaning to write. The first recorded mining of graphite was at Borrowdale, England, where pieces of it were turned up in the

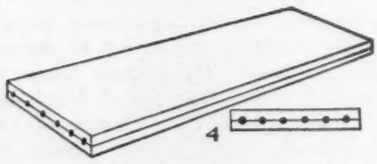


1—*Cedar Pencil Slat*—a little longer than a pencil, the width of 6 pencils, the thickness of a half pencil.

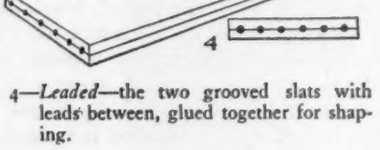
2—*Grooved for the Leads*—the grooves in depth are one half the thickness of the lead.



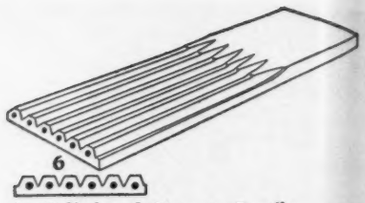
3—*The Leads in the Grooves*—a slat, similarly grooved, is fitted over this.



4—*Leaded*—the two grooved slats with leads between, glued together for shaping.



5—*Half-shaped, Round Pencil*—under the high speed, revolving cutters the half pencils have been formed.



6—*Half-shaped, Hexagon Pencil.*

7—*Full-shaped, Round Pencil*—repeating the operation with the slat reversed, completes the shaping process.

8—*Full-shaped, Hexagon Pencil.*

STEPS IN MAKING A KOH-I-NOOR PENCIL

1710, at which time it was found that clandestine operators had carried the workings considerably deeper into the rock. Resumption of activities followed the discovery of new deposits that kept the property running for some years; but by 1791 the annual output was only 5 tons and the material was of poor quality. The best grade of graphite was then selling for from 8 to 12 shillings a pound.

Up to this time pencil makers had made use only of the mineral in the solid form. There were large accumulations of finely divided graphite in the Borrowdale Mine, while workings that had been opened meanwhile in Bohemia and elsewhere produced graphite that was so intermixed with other material that the whole had to be powdered to recover it. Consequently there was need of some means for consolidating it. In the search for a suitable binder, various materials such as glue, antimony, gums, and isinglass were tried without great success. Most of this experimenting was done by pencil makers in Nuremberg, Bavaria. In 1790 the present method of mixing clay with the graphite was patented by Nicholas Jacques Conte, a French mechanic, and Josef Hardtmuth of Vienna, founder of the firm of L. & C. Hardtmuth. Clay serves not only as a suitable binder but also to vary the degree of hardness which, in turn, affects the blackness of the lines produced by different grades of pencils.

In the interval that has elapsed since the Borrowdale Mine was discovered, many extensive deposits of graphite have been opened in various parts of the world. Of these, the products of Ceylon and Madagascar are said to be the best for pencil making. That from Ceylon is especially suitable because it is of the amorphous type and has better marking properties than the others. Although the mineral was originally used almost exclusively as a writing material, its application since then has become widespread and varied, and the pencil industry now consumes only about 7 per cent of the annual output.

As soon as graphite was obtainable on the Continent of Europe, pencil making began there. One of the early centers of manufacture was Nuremberg, where the first of a number of very small establishments was opened in 1662. Originally the work was done entirely by hand by cabinetmakers, and it was not until 1731 that pencil making was recognized as an industry. Production was so small in the beginning that it was customary for the master's wife to carry the week's output to town in a basket. To illustrate the methods then in use, there follows a description written in 1726 by a pencil maker of Berlin. It is taken from the Koh-I-Noor booklet, *The Pencil from 1565*, which is also the source of most of the other historical material given here.

"The lead cutter pounds the graphite in a mortar, and by sifting two or three times frees it of all earthen particles such as sand. In a crucible, to every pound of graphite a fourth or a half pound of sulphur is added, melted and thoroughly mixed. After cooling and before it is quite dry, the mass is put on a board and kneaded just as one would knead bread. This must then become fully cooled before it can be further worked. With a fine saw, the pencil-maker divides this cake into small plates from which he saws the four-cornered leads of desired size. The workman cuts the wood to the requisite size, and forms the groove for the lead either with a grooving plane or by burning it out with a red hot iron tool. The lead is glued in the groove and a piece of wood glued over it to complete the pencil. The end of the pencil showing the lead is shaped to a neat point with a file. The entire surface of the pencil is then carefully finished by scraping with glass. It is evident that the pencil maker, to show any profit, must complete the pencils in a short time, for a dozen cost only eight groschen."

Modern pencil making starts, of course, with the leads. The first step is to clean the graphite, for even the purest natural mineral usually contains some foreign material that must be removed if the leads made from it are to write smoothly. Cleaning is done by the gravitation process in a series of tubs. The finely ground graphite is mixed with hot water and introduced into the first tub. There it is agitated, and the overflow goes over the side and through a sieve into the second vessel, which is at a lower level. Usually there are six tubs in line and the sieves grow progressively finer, the last one having about 200 openings to the square inch. In each tub the impurities, being heavier, sink to the bottom, while the graphite floats and passes on.

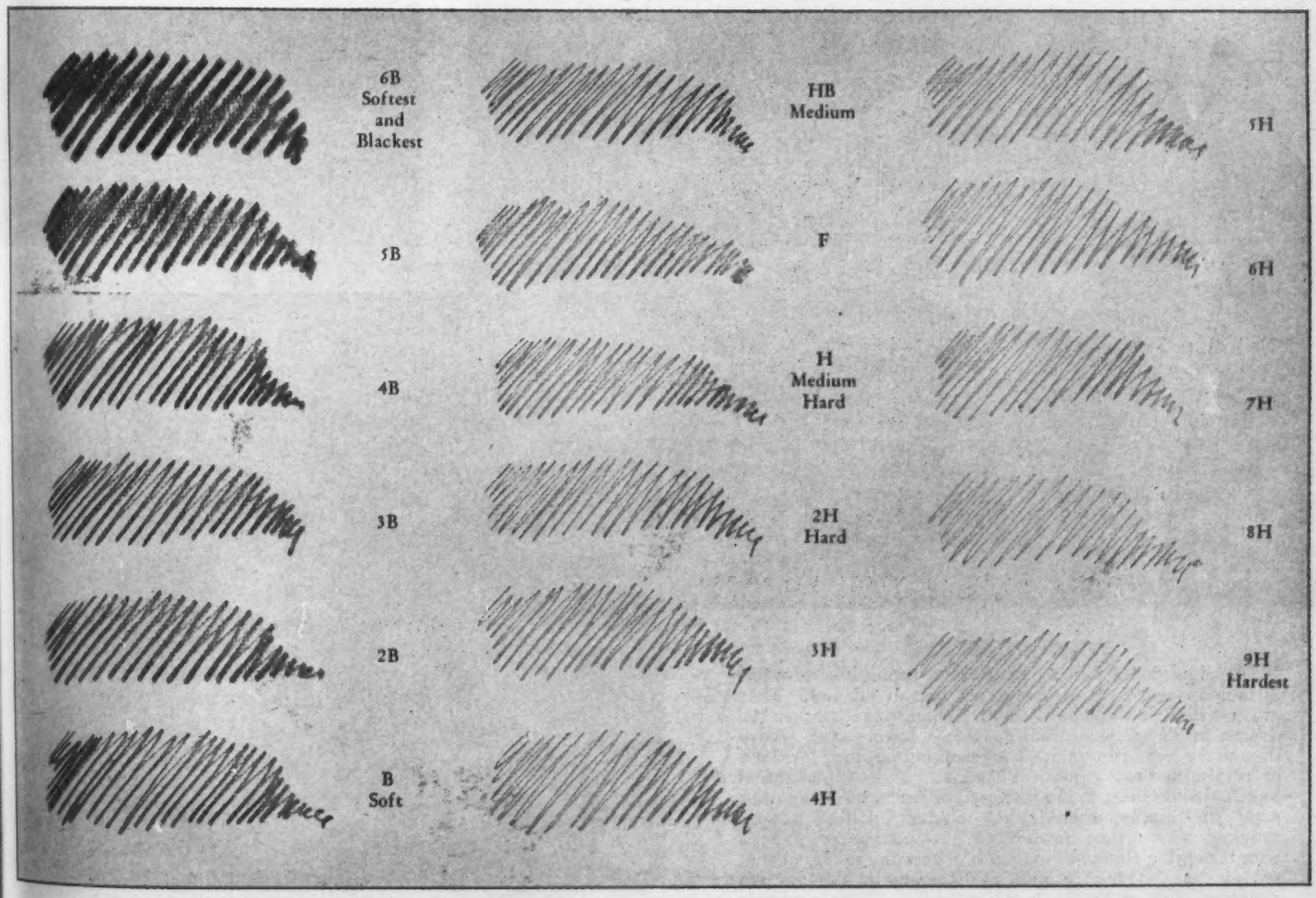
Czechoslovakia has always been considered the source of the finest clay for pencil use. The clay is purified by the

method just described for graphite; but even greater care must be taken with it, for everyone knows the effect of grit in a lead pencil. Both the graphite and the clay are dewatered in separate filter presses, are dried, and then mixed, the proportions being determined by the grade or hardness of the lead to be produced. Water is added to this mixture before it is sent to the grinding mills, where the final traces of grit are removed by pulverization. The time it takes to do the milling varies with the quality of lead desired. For Koh-I-Noor pencils it is approximately two weeks.

The leads are formed by extruding the mixture through a die of sapphire, or other gem stone, under hydraulic pressure. As the slender string of plastic material comes from the die, a worker breaks it into pieces of the required length. These are laid on a flat iron plate and rolled by hand to straighten them. They are next dried; cut into pencil length; and then packed in crucibles and tempered by heating them to a temperature of more than 2,000°F. in a sealed furnace. The final treatment consists of immersing the leads in a bath of hot oil and wax,

VALUED EMPLOYEE

This nameless and tail-less Manx cat and three of her offspring more than earn their keep by mousing in the Bloomsbury factory. Mice eat pencil leads and would do considerable damage save for the nightly vigilance of the feline quartet.



THE SEVENTEEN DEGREES OF HARDNESS

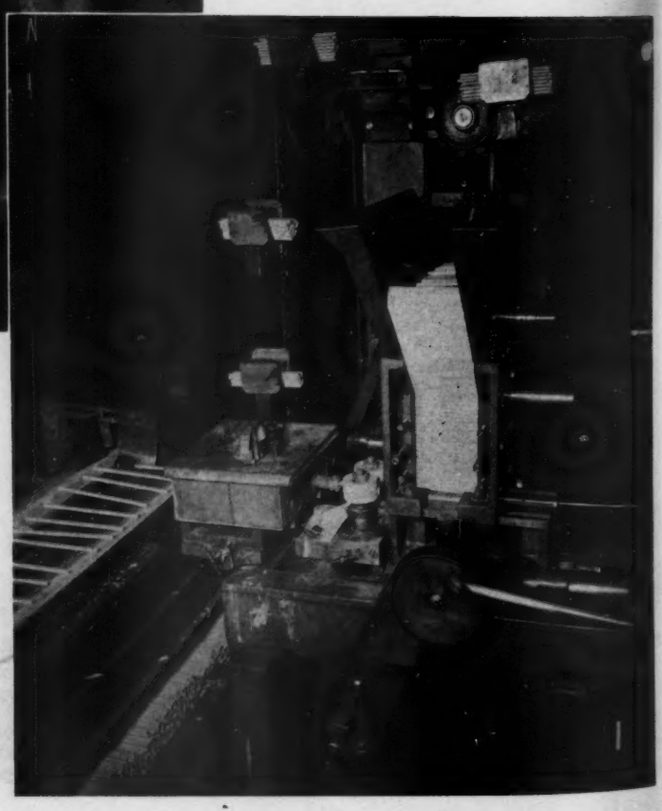
These various shades of black are obtained by mixing different amounts of clay with graphite. Although other manufacturers of drawing pencils use the same designations as Koh-I-Noor (one puts out 18 degrees), there are slight variations in the markings made by pencils of the same degree produced by different concerns. Commercial pencil users are not so exacting as artists and engineers and their needs are satisfied by a range of five degrees of hardness. The most popular grades are the No. 2, which is equivalent to the HB drawing pencil, and the No. 2½ or 2A, which corresponds to the F drawing pencil. Other commercial grades are Nos. 1, 3, and 4.

which improves not only their smoothness but also their general marking quality. After they have been dried and cleaned in sawdust, they are ready to be encased in wood.

The only acceptable wood for lead pencils is cedar, which is soft enough to be readily cut by either a knife or a pencil sharpener without burning or splintering. The best material for this purpose comes from Tennessee and Florida and is grown in soils high in lime content. It is especially suitable because of its comparative freedom from pitch. The United States furnishes cedar for all the world's high-grade pencils. When Koh-I-Noors used in this country were made abroad, the wood was exported to Czechoslovakia and then a duty had to be paid to import the pencils. The supply of first-class southern cedar for pencils is getting low, and for some time past a considerable quantity of it has been coming from old rail fences, barns, and other structures. There is one advantage in this—the material has been thoroughly dried and seasoned by nature. Owing to the shortage of southern cedar, its use is confined to the highest-quality drawing pencils. Those of lower grade and commercial pencils are made from California incense cedar which is slightly softer and is available in ample quantities.

The characteristic red color of cedar is deepest toward the center of the tree. The whiter material near the bark is not so desirable as the heartwood. All cedar is naturally knotty, so care has to be taken to select straight-grained pieces. The material arrives at the pencil factory in flat slabs called slats. These are slightly thicker than one-half the diameter of a pencil, a little longer than a pencil, and from two to six times as wide. The slats are kiln-dried before they are bought, and stocks at the factory are kept in a dry place. This is necessary to prevent warping, which is probably the greatest single trouble that pencil makers have to guard against.

In one operation, automatic machines plane a slat perfectly smooth on both sides and cut grooves in one face deep



FINISHING STEPS

1- The plain cedar pencils are pushed through a reservoir of lacquer and onto the conveyor belt at the left. They are carried through a heated compartment for initial drying in 35 seconds, then drop to a lower level, where they move forward again. It takes about an hour for them to return to the lacquering station. There mechanical hands elevate them to the feeding hopper to begin another trip. The number of coats they receive has been greatly reduced by wartime restrictions. 2- Lacquered pencils pass through a stamping machine, where the name, grade, etc., is imprinted on them. 3- Commercial pencils are provided with an eraser in this machine, which performs the four successive steps involved. 4- Expert inspectors examine the finished pencils for straightness, finish, and freedom from end checks. 5- Koh-I-Noors are packed in dozen lots in metal boxes that keep them straight even in humid areas where the porous cedar tends to absorb moisture and become warped.

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enough to take half the diameter of the lead and a single groove in the reverse face to serve as a guide during a subsequent machine operation. The number of grooves for leads varies with the width of the slat, and the size of the grooves varies with the grade or hardness of the pencil, the leads gradually increasing in diameter as their hardness decreases. This gives all leads approximately equal physical strength and widens the line they will produce in direct ratio to their softness. The grooving machines work to a tolerance of 1/1,000 of a millimeter. Of incidental interest is the fact that virtually all modern pencil-making machinery comes from two factories. It is a specialized field in which the demand is small, for there are only sixteen pencil-manufacturing concerns in the United States. However, they produce as many as 10,000,000 gross in a year.

The side of the slat that was grooved for leads is brushed with glue, the leads are laid in the depressions, and a second grooved slat of the same width is fitted over it. The best quality of hide glue is used and is kept hot in pots that are steam-jacketed. The water required in mixing it is kept down to a minimum, and the room temperature is maintained at 82°F. to promote drying of the glue, for any moisture that is added to the wood must be removed later or the pencils will warp. A quantity of these glued-together slats is then put in a clamping fixture and placed in a hydraulic press where the lot is subjected to a pressure of 80 pounds per square inch. The clamp is screwed up tight to hold this pressure and, together with the slats, is transferred to a drying kiln through which fans blow fresh air that is heated by passing it over steam pipes. The time of drying varies with the grade of the pencils and ranges from 24 to 48 hours. The temperature also varies, but averages around 100°F. When dry, the pairs of slats go to an end-drumming machine where the glue on the ends is removed by passing them between two revolving heads faced with sandpaper. If slats containing two different grades of lead have to be handled in close succession, their ends are painted different colors so they can be distinguished during subsequent operations and thus eliminate any possibility of confusing them.

Next comes what is known as shaping —converting the double slat into individual pencils. This is done by feeding it twice through a machine containing steel knives which revolve at high speed. In the first pass the slat travels over the knives and its bottom face is cut. It is then dropped to a lower level and travels under the knives, which complete the operation by cutting the upper face, the two cuts meeting at the center. The single grooves that were cut in each pair of slats when they were formed serve to guide the piece through the shaping machine, thus making sure that the cuts will be in the correct places and that the leads will be in the exact centers of the pencils.

The shape of pencils may be varied by utilizing different cutting knives. Drawing pencils are always made hexagonal in section so that they will not easily roll off the sloping tables that are commonly used by draftsmen, artists, and kindred workers. Most commercial pencils also are hexagonal because of trade demands, although round ones are considered to be the easiest to hold. Some pencils for special purposes, such as those for carpenters, are of oval shape.

The plain cedar pencils then go to sanding machines where their surfaces are made perfectly smooth. Fine sandpaper moves back and forth over them length-

wise. Hexagonal drawing pencils receive this treatment in six stages and are turned one-sixth of a revolution between successive ones so that all the faces will be sanded equally.

The pencils are now ready to be colored, and this, too, is done mechanically. Koh-I-Noors have always been finished in a golden-yellow, and this early proved to be a selling point, for persons who could not remember their name asked for them by color. Gradually, golden-yellow came to be recognized as the mark of a pencil of high quality and was adopted by many makers for pencils of various kinds. It is said that even today it is the predominating color in the industry. A seal coat to fill the pores of the wood and confine any oil remaining in it is first applied, and this is followed by finishing coats of lacquer. Before the war, Koh-I-Noors received fourteen applications of lacquer, but this has been cut down because of Government restrictions in the use of the finishing material. The consumption of lacquer is limited to 1 gallon for each 100 gross of pencils, whereas as many as 5 or 6 gallons were formerly applied.

In the coloring operation the pencils are fed, one at a time, from the bottom of a hopper to a mechanical plunger that pushes them horizontally through an opening in the side wall of a container of lacquer. They emerge from the opposite side after having had the color smoothed on and excess lacquer wiped off in passing through a rubber washer. As they come out, the pencils drop upon a pair of traveling belts which support only their ends to prevent the lacquer from being rubbed off. They are carried through a steam-heated drying chamber and deposited in a basket. This cycle is repeated until the requisite amount of coloring matter has been applied. Prior to receiving each coat of lacquer, the pencils are turned end for end to make sure that the covering is uniform throughout the entire length. A finishing coat of clear lacquer is put on in the same manner, after which the pencils go to a sizing machine.

In the sizing operation the pencils are carried on a wheel between two opposed revolving drums that are faced with sandpaper. These remove the varnish from the ends of the pencils and also reduce the length to exactly 7 inches. Following sizing, the ends of Koh-I-Noors were formerly given a gold finish by spray painting, but this embellishment has been omitted since the war began. The next step is the stamping of the name, grade, and other identifying marks on the pencils.

The lettering on Koh-I-Noors is 16-carat gold leaf. For convenience in handling, this is backed up with paper and received in a roll, from which it is unwound as required. The work of stamping is similar to that of typewriting, with the strip of gold foil taking the place of the inked ribbon. Electrically heated metal dies bearing the desired lettering in relief are pressed against the paper side of the strip of gold leaf with sufficient force to impress the letters in the wood, the gold being transferred to the pencil in the operation. In the case of the 6-sided pencil, the grade designation appears three times—on alternate faces—and is consequently always visible when the pencil is lying on a drawing board or desk. Stampings on commercial pencils are usually made with bronze.

Finished Koh-I-Noors are cleaned in sawdust and are then ready for inspection and packing. Inspection is very rigorous, and pencils are rejected that appear perfect to the layman. They are rolled on a flat surface to test them for straightness, and even the slightest degree of warping prevents them from being accepted. They are also inspected for finish and chipped or splintered ends. An average of one pencil in ten is rejected. These are not wasted, but are cut in two or more pieces and sharpened, forming short pencils that are sold at reduced prices for special purposes. One of the chief outlets is the golf club, where they are given to players for marking their scores. The pencils that pass inspection are hand packed in metal boxes containing a dozen each. The packer puts the quota for each box in a metal jig to wrap them in cellophane, and any warped pencils that have come through inspection are now detected and removed.

The manufacture of commercial grades of pencils follows the procedure that has been outlined, with minor variations. The different brands are ordinarily finished in distinctive colors. The Bloomsbury plant puts out one where a panel of contrasting color near one end identifies the grade or hardness of the lead. Commercial pencils are provided with an eraser, and this calls for a separate manufacturing operation. The rubber was formerly encased in a brass ferrule, but wartime restrictions have necessitated using substitutes—paper for the cheaper pencils and plastic for the better ones. Four steps are involved in putting on an eraser, and all are carried out mechanically. First a shoulder is cut in the pencil; next the ferrule is pressed on; then glue is injected inside the ferrule; and finally the eraser is inserted. Pencil makers are now limited to 15 per cent of their normal peacetime consumption of rubber, and all their allotment is of the reclaimed variety.

In addition to conventional lead pencils, the Bloomsbury plant makes copying pencils, 64 shades of colored pencils for artists, and various special crayons, chalk sticks, charcoal sticks, and other types of drawing equipment.

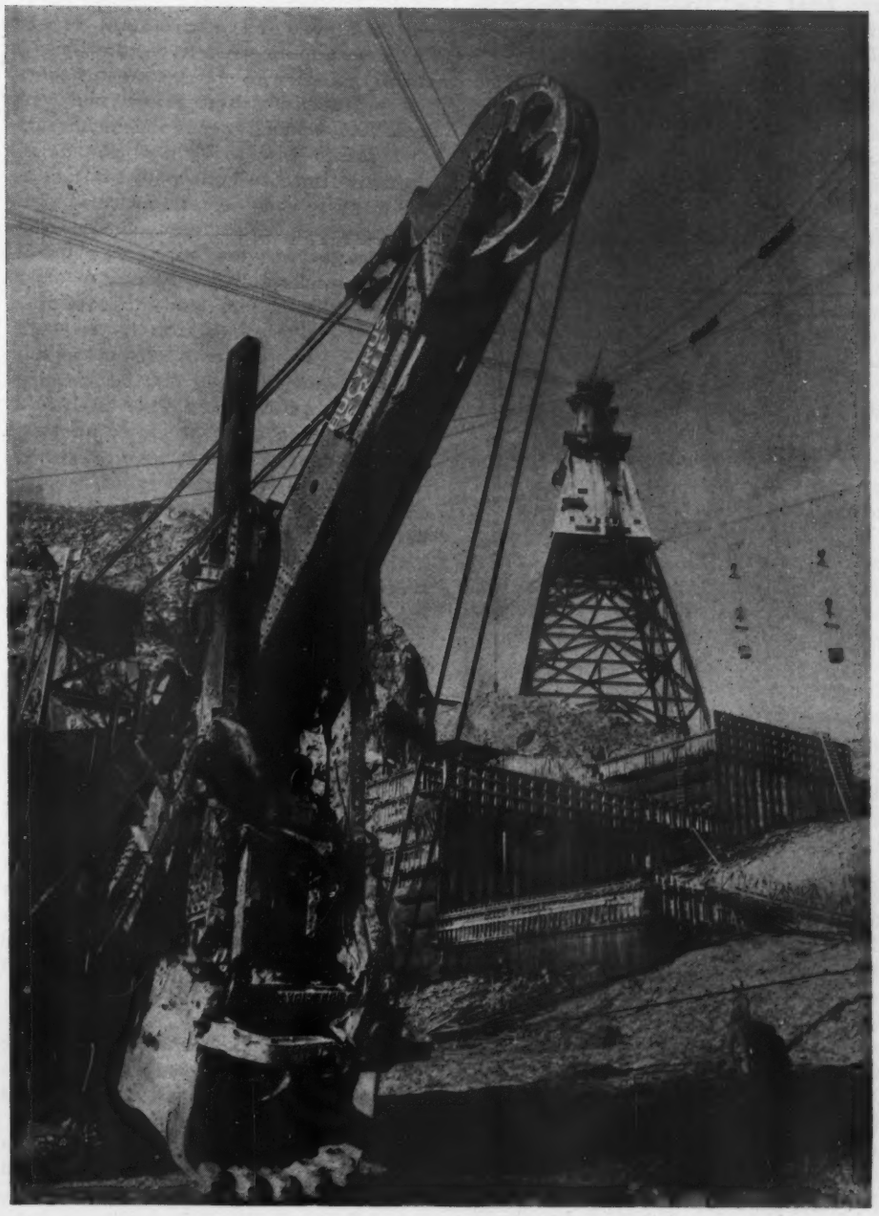
UTILIZING WASTE HEAT

When the factory is working at capacity—100,000 pencils a day—it generates around a ton of sawdust daily. Most of this is in a finely divided state and is withdrawn from the various machines by a Pangborn dust-collecting system. This, incidentally, removes from the building about 9,000 cfm. of air which was formerly replaced by air drawn in through spaces around windows and doors. In the wintertime the working areas had to be supplied with considerable heat in order to maintain a comfortable temperature for the employees. Last fall the company devised a scheme of utilizing waste heat for this purpose, and this promises to cut down the fuel bill by 25 per cent. From the collection unit the sawdust is conveyed underground to an incinerator (seen at the left) the metal shell of which is inclosed in refractory brick, leaving an annular space for the circulation of air. Now, approximately 6,000 cfm. of the air withdrawn from the building is heated by the sawdust fire and, after being filtered, is sent back into the factory through the overhead pipe shown.

Making Wire Rope Last Longer

Allen S. Park

Illustrations from
American Steel & Wire Co.



WIRE ROPE IN CONSTRUCTION

Wire rope is an indispensable part of cableways, power shovels, and other vital equipment that is used in rearing large dams and in carrying out other construction projects.

MEASURING SHEAVE GROOVES

Grooves in sheaves and drums should be slightly larger than the rope diameter to avoid pinching and binding the strands. When wear reduces the recommended tolerance for a rope of a given size the grooves should be remachined.

THE need of care in the maintenance and operation of wire rope will be apparent when the true nature of wire rope is understood. A little reflection will destroy any preconceived idea that wire rope is static metal and will reveal, instead, that it is a machine. This is so because it is made up of a large number of individual parts, each of which moves when the rope is in service. With this conception clearly established, it will be evident that wire rope rates the same sort of attention that is given to any other piece of machinery.

As is the case with all mechanical equipment, the importance of taking adequate care of wire rope is emphasized in these times when the materials entering into it are scarce and when the demands for it are far greater than they are under normal circumstances. Moreover, approximately 95 per cent of the wire rope made today goes directly or indirectly into war production. In 1941, the industry produced 172,483 tons of wire rope and sold 25,354 tons to the Government, whereas in 1938 less than 4,000 tons went to Federal agencies. Probably little known is the fact that there is from 250 to 5,000 feet of wire rope in each military airplane. If the average is 1,000 feet, which seems to be a conservative figure, the 60,000 planes scheduled for 1942 will require 60,000,000 feet, and all of it hidden from view. As a further illustration of the essential part wire rope plays in warfare, consider that 80,000,000 feet of it was used during the last world conflict in the building of

EFFECT OF KINKING

Kinks greatly reduce the life of wire rope and should be prevented. Kinks start with a loop, and if the loop is removed at the stage pictured at the top no damage will be done. The second picture shows a kink, and the next one illustrates the damaged strands and wires that result therefrom. Continued use of a rope in that condition will cause it to break up very quickly, as shown at the bottom.

antisubmarine nets in the North Sea.

Two factors enter into getting the maximum service from wire rope: selecting the right rope for the job, and giving it proper care. They will be considered here in this order. There are more than 1,500 types and sizes of wire rope, and each is engineered for a specific purpose. Their predominating fields of application are hauling, hoisting or conveying loads, supporting or strengthening structures, and transmitting energy. To meet the manifold demands for strength, toughness, resistance to corrosion, and capacity to withstand abrasion and abuse, they are manufactured from iron, traction steel, cast steel, mild plow steel, plow steel, and improved plow steel. Any of these may be galvanized in order to increase its resistance to corrosion. Wire rope is likewise made from special corrosion-resistant metals such as stainless steel and bronze.

The minimum strength requirements of each grade of wire are defined in Federal Specifications for Wire Rope and vary from 70,000 pounds per square inch for uncoated iron wire to 230,000 pounds for uncoated improved plow-steel wire. In service, wire is subjected to several kinds of stresses, the most frequently encountered being direct tension; those attributable to acceleration, to sudden or shock loads, and to bending; and those resulting from several forces acting at one time. Most of these can be converted into simple tension, and a rope of the required strength can be selected accordingly. Allowance should be made for an adequate factor of safety. This varies with the application, and its determination involves consideration not only of the load applied but also of the speed of operation, type of fittings used for securing the rope ends, acceleration and deceleration, length of rope, size and location of the sheaves and drums, factors causing abrasion and corrosion, facilities for inspection, and possible loss of life and property in case of rope failure.

The minimum acceptable safety factors for various representative fields of service are: track cables, 3.2; guy wires, 3.5; mine hoists, from 8 for depths of 500 feet to 4 for depths of 3,000 feet and more; miscellaneous hoisting equipment, 5; haulage ropes, 6; small electric and air hoists, 7; hot ladle cranes, 8; passenger elevators, from 7.5 for car speeds of 50 feet a minute to 11.87 for car speeds of 1,500 feet a minute. Experience has established these figures to be the lowest consistent with economy and safety for the average installation. Larger safety factors are desirable and will in most cases increase economies.

The size, grade, and construction of a rope have a bearing on its strength, and all should therefore be considered. Wire rope is made of strands, their number and the number of wires to each strand depending upon the use to which the rope is to be put. The greater the number of strands and the number of wires per strand, the more flexible the rope. Standard hoisting rope for mine hoists and for conveyors, derricks, and similar equipment is made of six strands with nineteen wires to the strand. Special flexible rope has six strands of 37 wires each, and extra-flexible has eight strands of nineteen wires each. Standard haulage rope has six strands of seven wires each and is much stiffer than hoisting rope.

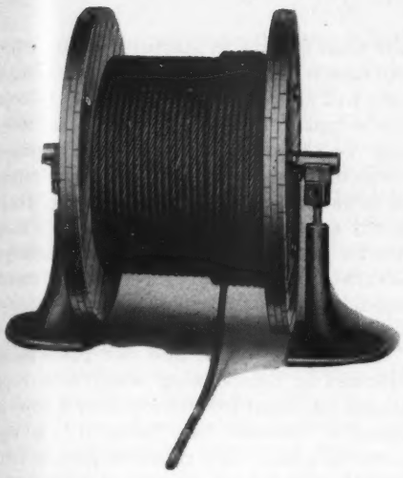
Fatigue, which is a breaking down of the grain structure of the wires, results from repeated bending such as a rope experiences when passing over sheaves or drums and then straightening out again. To resist fatigue, a flexible rope of smaller wires should be used. A rope's capacity to withstand abrasion is affected by the size, the carbon and manganese content, the heat treatment of the outer wires, and by its construction. The larger outer wires of a relatively stiff rope are more resistant to abrasion than the smaller wires of a flexible rope. This likewise applies to wires of high carbon and manganese content, and those that have been thoroughly heat treated. Ropes of Long-lay construction—that is, with the wires in each strand and the strands themselves twisted in the same direction—will withstand abrasion better than those of standard regular-lay construction. The capacity to resist crushing, distortion, and general abuse is greatest in ropes having large outer wires and a wire center instead of the usual fiber core. The use of slightly flattened instead of round strands produces rope having a larger metallic area, and this prolongs service life where abuse is a factor.

The selection of the most suitable rope for a given job involves a thorough knowledge of the subject, and, in case of doubt, the advice of a reliable manufacturer should be obtained. Once the rope is chosen, proper handling and care will prolong its life, add to the safety of the workmen, and give a maximum return on the investment.

Wire rope is ordinarily received wound on reels, and there are three correct methods of unwinding it. First, mount the reel on a horizontal shaft supported by a jack at either end and pull the rope from the reel by taking hold of the end and walking away with it. Second, mount the reel on a vertical unwinding stand and remove the rope as just described, taking care to keep it under enough tension to prevent it from accumulating slack and dropping below the bottom reel head. Third, hold the end of the rope and roll the reel along the ground. When transferring a rope from a horizontal reel to a drum, it should travel from the top of the reel to the top of the drum, or from the bottom of the reel to the bottom of the drum. By observing these instructions it will be kept free from reverse bends which cause it to become livelier and harder to handle. The only way to unwind a coil is to hold the outer end of the rope and roll the coil along the ground like a hoop. The foregoing instructions may seem to be so simple as to be superfluous, but failure to

A WELL-MADE SEIZING

Seizings are required to prevent the untwisting of all nonpreformed wire ropes unless the ends have been attached to some permanent fitting. Seizings can be applied to small ropes with a pair of hand cutters. For larger ones the use of a round bar is recommended.



UNREELING AND UNCOILING

If wire rope is unwound from stationary reels or coils it will inevitably kink. Consequently, it is imperative that the reel rotate as the rope unwinds. One approved practice is to mount the reel on a shaft supported by two jacks, as shown here.

follow them has ruined many a length of rope.

A new wire rope should always be run with a light load, or with no load, for a short period after it has been put in place. During this breaking-in process its component parts will adjust themselves to operating conditions. Its life will be extended considerably by breaking it in properly. In the case of a rope that is wound on a drum in service it is good practice to cut off a short piece at the drum end from time to time because wear and fatigue are usually most severe at certain points of contact with the equipment over which it passes. Cutting back as just suggested will change its position with respect to these points and subject different parts of it to the destructive forces. Another conservation measure is to reverse the ends so as to distribute wear and fatigue resulting from bending and vibration. These forces are generally exerted more on one-half the rope than on the other, and changing it end for end tends to equalize their effect and to prolong its life.

When a rope is in use, its many individual wires move in relation to one another. It is therefore necessary to protect these bearing surfaces from wear by lubricating them regularly. Lubrication also prevents the wires from rusting. The hemp center in most ropes serves as a reservoir for the lubricant, which is generously applied in the course of manufacture. This treatment is not sufficient for the life of the rope, however, and a good grade of oil or grease should be applied periodically. The lubricant should be chosen with the size and construction of the rope and its working conditions in mind. In general, a stiff rope, with its fewer and larger wires, needs a heavier lubricant than a more flexible one with a greater number of wires. It should be free from acids and alkalies, and its composition should be such that it will not "fight" with the lubricant already on the rope. Other requirements are that it should be sufficiently adhesive to remain on the rope, should be able to penetrate between the wires and strands, should be nonsoluble under prevailing service conditions, should have a high film strength, and should resist oxidation.

A rope that has been in service should be cleaned before it is lubricated. If it has been working in a wet atmosphere it may be coated with a film of hydrated rust that cannot be removed until the rope has been thoroughly dried out. No good is done by putting oil or grease on top of such a surface. It may be cleaned with a stiff brush and kerosene or gasoline, by drawing it through a tightly wrapped swab, or the dirt and grit may be blown off with compressed air or superheated steam. After it has been cleaned, the lubricant may be applied by any suitable method. The object is to give the entire length a uniform coating, and this may be done with a stiff brush, by passing the rope through saturated waste or through a box or trough of lubricant, or by allowing the lubricant to drip onto the rope, preferably at a point where bending opens it slightly. Experience will show how often to lubricate for best results. A rope that is taken out of service for a considerable period should be cleaned, lubricated, and stored in a dry place that is protected from the elements and is free from acid fumes.

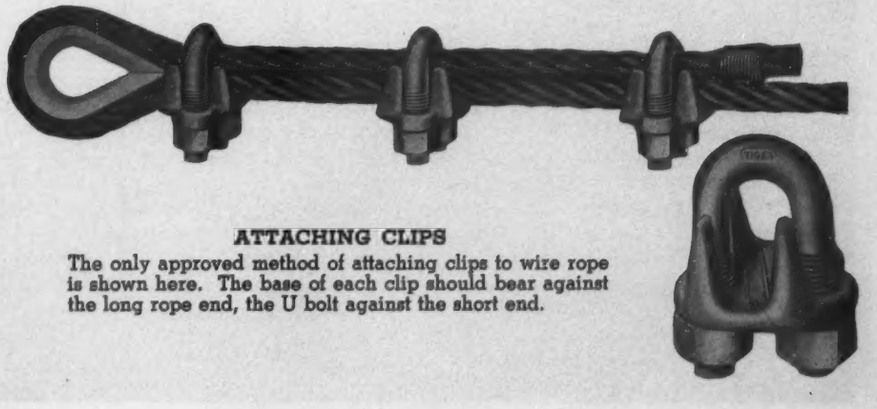
Wire rope should be handled so that it is neither twisted nor untwisted. Do not allow it to form a small loop, as that will develop into a kink if sufficient tension is applied. The wires are permanently bent and damaged at the point of kinking and usually cannot be repaired.

Preformed wire rope is made up of wires which, before they are assembled, have been given the shape that they will assume in the rope. This removes internal stresses, virtually eliminates liveliness, makes it easier to handle, and lessens the likelihood of damage from kinking or fouling. The ends of all nonpreformed wire ropes should be seized, or bound with wire, to prevent untwisting unless they have been eye-spliced, socketed, or attached to some other type of permanent fitting. If the rope is to be cut, seizings should be applied beforehand on both sides of the point where the cut is to be made. The seizing wire should be of the annealed-iron grade. The number of seizings required varies with the size and construction of the rope. Information on this point, as well as detailed instructions on how to make approved seizings, may be obtained from any reliable wire-rope manufacturer.

The methods by which wire-rope clips, wedge sockets, and other fittings are secured to wire rope and by which it is spliced have a direct bearing upon its life. It is impossible to go into these matters in an article of this length, but illustrated literature covering them fully will be supplied by reputable wire-rope makers upon request.

All wire ropes except those for stationary uses are subjected to bending around sheaves or drums, and the service obtained from them depends largely upon the proper choice and location of those sheaves and drums. If the sheaves are too small, the rope will lose strength quickly because of the inability of the individual strands and wires when bent to adjust themselves to their changed positions. Rope strength decreases markedly as the sheave diameter grows smaller in relation to the diameter of the rope. Another effect of bending is fatigue, and this manifests itself in the tendency of the wires to break off squarely. Bending causes readjustments in the positions of the strands and wires, as well as bending of the wires themselves. This bending of the wires results in a rearrangement of the intermolecular structure of the steel and, if it is repeated many times, will have an embrittling effect.

It has been learned from experience that a very definite relationship exists between the outer wires of a rope and the size of the sheave or drum about which the rope operates. If the sheaves or drums are smaller than 200 times the diameter of the outer wires, the latter will acquire a permanent set if the rope is heavily loaded. It is recommended that sheaves or drums for heavily loaded, fast-moving ropes have a diameter at least 800 times that of the outer wires of the rope. For mine



ATTACHING CLIPS

The only approved method of attaching clips to wire rope is shown here. The base of each clip should bear against the long rope end, the U bolt against the short end.

hoists, the ratio is usually about 1,000 to 1, and for elevators approximately 900 to 1. This subject of sheave and drum sizes is complicated by other factors and can best be summarized by quoting from a booklet, *Valuable Facts About the Use and Care of Wire Rope*, which is published by the American Steel and Wire Company:

"It is impossible to give a definite minimum size of sheave or drum about which a wire rope will operate with satisfactory results because of the other factors affecting the useful life of the rope. If the loads are light, or the speeds slow, smaller sheaves and drums can be used without causing early fatigue of the wires than if the loads are heavy or the speed is fast. Reverse bends, where a rope is bent in one direction and then in the opposite direction, cause excessive fatigue and should be avoided whenever possible. When a reverse bend is necessary, larger sheaves are required than would be the case if the rope were bent in one direction only."

Grooved drums are preferable to smooth ones because the grooves provide better rope support than do the flat surfaces of ungrooved drums. The result is more uniform winding, with less abrasive wear on the ropes. Grooves should be smooth and their depth should not be more than 10 per cent of the rope diameter. Deeper ones will cause undue rope distortion at the points of crossover from one groove to the next.

Grooves in both drums and sheaves should be slightly larger than the rope to prevent pinching and binding of the strands and to permit the rope to adjust itself to the radius of curvature. Sheaves should be aligned so that the axis of the rope is parallel to a line drawn from the center of one sheave to the center of the succeeding one. If the rope approaches the sheave or the groove in a drum at an angle, it will wear excessively by bearing against flanges or by dragging across shoulders. The greater the angle of approach to the groove, the wider the groove should be to prevent undue wear.

Where a rope passes from a drum to a lead sheave, it is important that the distance between them be great enough to reduce the angle of approach, which is called the fleet angle. The best service is obtained when the fleet angle is not greater than 1½ degrees.

Jerking a wire rope produces sudden stresses that may break it or at least hasten its destruction. Because of this, loads should be applied gradually and the rate of acceleration should be kept as uniform as possible. Where there is sag in a rope, supporting sheaves and rollers should be used to prevent dragging and thus reduce abrasive wear. They also tend to dampen vibration, which is especially desirable on long inclines operating at comparatively high speeds. Guide sheaves and rollers should be at least six times the rope diameter if grooved and nine times the rope diameter if smooth. They should not be too heavy, for they will then be slow in starting to turn when the rope is put in motion and their momentum will keep them turning after the rope has stopped moving. In either case, there will be rope slippage with attendant abrasion of the outer wires. The winding of more than one layer of rope on a drum is not good practice. However, if it cannot be avoided, care should be taken to see that the succeeding layers do not cross-wind, but that the rope rests in the grooves formed by the preceding layer.

There are no hard and fast rules to be followed in determining when wire rope should be discarded. Sometimes a rope is replaced because the "stretch" is apparently gone. New rope has pronounced stretch, which lessens as the strands settle into place. Lack of stretch is not an indication that a rope is unsafe provided the wires are not broken. Some wires may snap in a new rope when they are adjusting themselves to the equalization of the stresses, but this does not necessarily mean that the rope is wearing out. However, if wires break after the rope has had considerable service, then its useful life is ended.

The nature of a rope's service and the possible consequences if it should break should be considered in determining when to replace it. The following suggestions, which are for general guidance only, were taken from *Wire Rope Safe Practices*, Pamphlet No. 26, published by National Safety Council, Inc.:

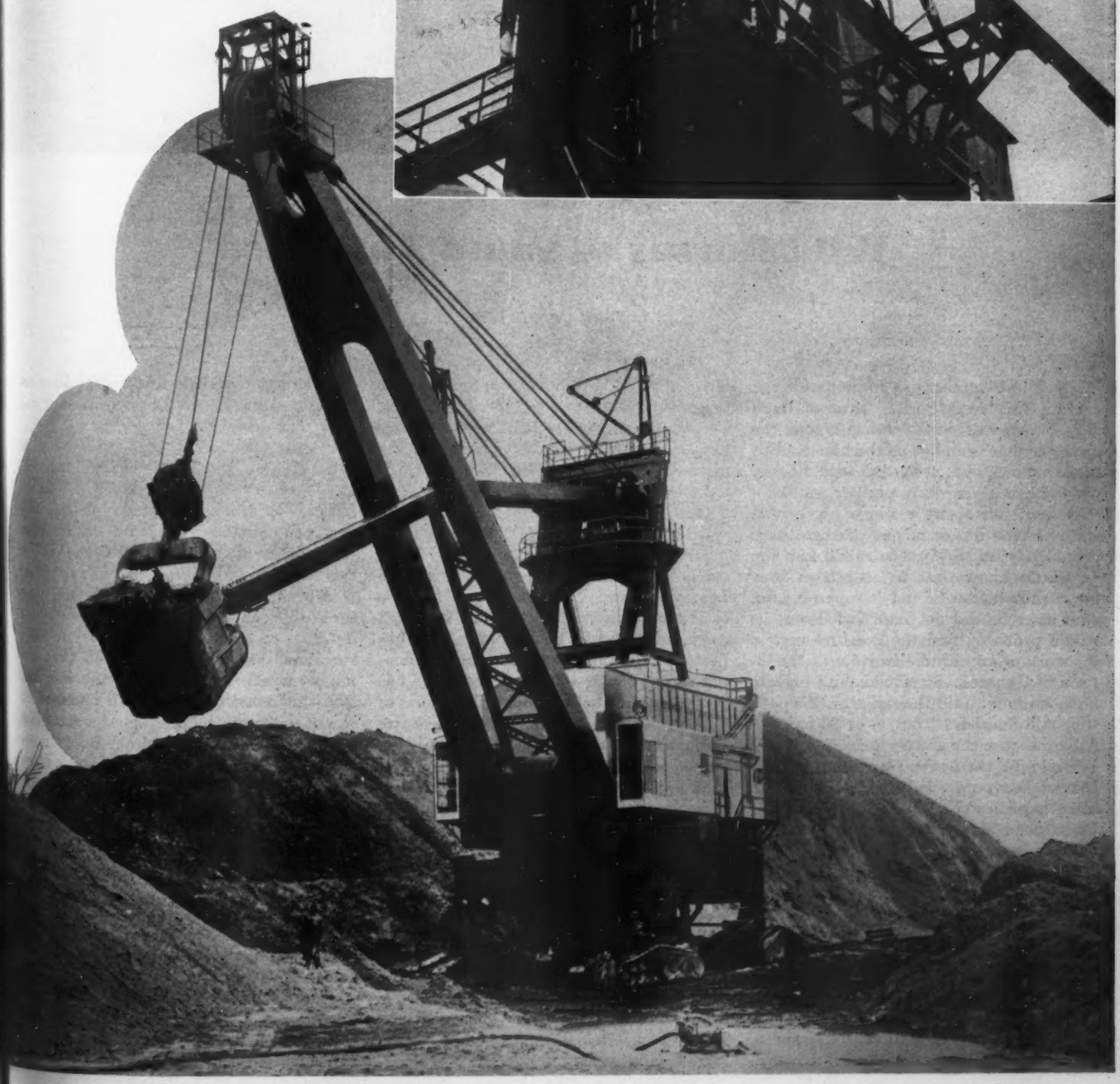
"If material only is hoisted and no

WIRE ROPE IN MINING

Both above and underground, wire rope contributes importantly to mining operations. The picture below shows a 3-drum electric hoist pulling a slushing scraper in an iron mine. On the opposite page are seen a mine tipple and a huge power shovel that is stripping overburden from a coal deposit.

service damage would result from failure of the rope, it may be used if there are no broken wires until the thickness of the outside wires is worn to about 65 per cent of their original diameter. However, the rope should, in any event, be renewed if it shows 10 per cent of broken wires per lay, or when adjacent broken wires in one of the strands exceed 20 to 25 per cent of the wires in that strand, even if the rope does not show appreciable wear.

"If persons are hoisted, or if material damage would result from failure of the rope, it should be renewed when, in the judgment of a qualified inspector, its strength is appreciably impaired by broken wires, or in any event when the outside wires are worn to a thickness of one-half their original diameter, even if there are no broken wires."



Ewing Galloway Photo

Wild Horses of Santa Ana Mesa

Carey Holbrook

WILD horses still roam the range in New Mexico. Most of them wear a brand, and of course the owner of that brand owns the horses. But make no mistake, they are wild horses, which have never worn a halter, sniffed a feed bag, nor spent a single night in a stall. If the owner of one of these nags should happen to want to round him up, he would know that he had been in a horse race before he got a rope on him. And after he did get him tied down, he would probably find the creature useless for work of any kind. In spite of the efforts of Government officials and private horse hunters to rid the range of this pest, they still flourish within 20 or 30 miles of Albuquerque, the state's main city.

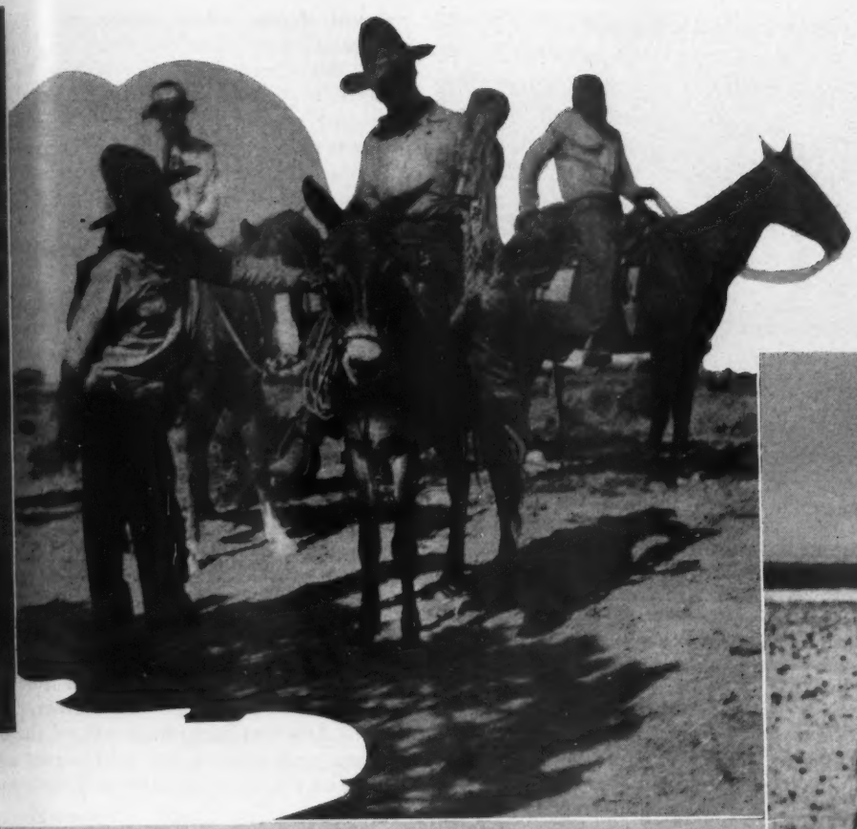
Well-nigh the entire free range in New Mexico is overcrowded with stock, and in some localities this is due to wild horses. For a good many years the Government has been engaged in rounding up these animals. To get rid of them it was the practice to take a Winchester, ride out on the range, and shoot the horses, leaving them where they fell. But this method of extermination had to be abandoned for two reasons: First, because of the opposition of the Society for the Prevention of Cruelty to Animals, and, second, because horse hunters with rifles are apt to shoot valuable domestic stock. Government officials maintain that the latter is the only valid excuse for not killing horses on the range, as the methods they have to employ to trap them are far more cruel than a merciful bullet through the brain.

Out in the Santa Ana Mesa country, 20 or 30 miles northwest of Albuquerque, are 60,000 acres in one block, and many thousands more adjoining, on which wild horses still range. Fifteen years ago it was estimated that from 1,800 to 2,000 head roamed this tract. Today the number has been greatly decreased, and probably does not exceed 300 or 400. This reduction has been brought about through the efforts of both private and governmental horse hunters, the one working for his own gain, and the other to ameliorate the overcrowded condition of the range. The larger part of this vast domain is unfenced. It stretches from the Rio Grande west.

Within this rugged territory are flat-topped mesas, black and frowning. Sandy arroyas go plunging across the landscape to spill out at last in the flat stretches of the Rio Grande. The freckled hillsides are dotted with pinion and scrub cedar. The rider who travels this expanse must be mounted on horseflesh sturdy and sure-footed if he is to get where he is going and back again. But in this raw and broken region is a year-round range for stock, and here the animals find refuge in a remote land inaccessible to anyone but the man on horseback.

North of the Santa Ana Mesa country is the range of the San Felipe Indians, and still farther north lies Santo Domingo land. West of it and located high on a hill-top is the pueblo of Zia, and west of that the country of the Jemez Indians. Within this area, probably 20 or 30 miles square, wild-horse hunters have been operating for many years. There was a time when one of them could move into the territory, run down any horse he wanted that did not wear a brand, and the nag was his. But that condition has been changed in recent years by the passage of a state law that gives the Cattle Sanitary Board power to take over any unbranded stock more than six months old and sell it through the proper legal procedure.

One of the oldest hunters in the section, in point of service, is Shorty Liston, who has been in the game since 1928. Shorty orginally came to New Mexico from Kansas, but that was a long time ago, more than 30 years to be exact. During all that time he has been engaged in ranching of some sort or another, but since 1928 he has been located on the west bank of the Rio Grande and about midway north and south of the Santa Ana Mesa country. His ranch house is an ancient adobe, built



HOME ON THE RANGE

Pictorial glimpses of the lives of wild-horse catchers. At the left, astride a mule, is the boss of Rincon Zarape, as Shorty Liston's ranch is known. Around him are some of his Indian helpers. Just below, is Mrs. Liston—Gene—on "Crip," a captured animal that became a good saddle mount. It takes fast horses to overtake untamed ones, and "Bess" was the speediest animal the Listons ever owned. Gene is seen holding her in the bottom view.

and originally belonging to Don Panfilo Lavato who immigrated into this land in an early day and lived there all his active life. The house sprawls out and overflows into corrals and horse lots. It has no modern conveniences, and the nearest neighbors are San Felipe Indians. The land spills over into the Rio Grande bottom where farming might be carried on to a limited extent if Shorty were a farmer. Shorty's family consists of his wife, Gene, and two foster children. At riding, roping, and running wild horses Gene Liston is just as good a man as the next cowboy, and when a roundup is on she takes her place alongside the best of 'em. She was practically born on horseback, has been ranching all her life, and likes it.

According to Shorty Liston, the first horses that became wild in the Santa Ana Mesa country belonged to a man named Baca whose ranch was situated there in years long gone. As the tale goes, Baca's son, and the mainstay of the old man, was killed in a roundup of horses, leaving his father with no one to look after his holdings. The Baca horses took to the open country, and it wasn't long before they were wild. Subsequently, Don Panfilo Lavato settled on the place that is now Shorty's headquarters, bringing with him a herd of horses headed by a big red-roan stallion called Sabine by the natives. This sturdy animal, with his red-roan sides splotched with white, left behind him on the range a trail of red-roan colts; and even now, after 50 years, that blood still breaks out, as evidenced by pinto and paint ponies. Old Sabine marked his get.

Don Panfilo was something of a horse trader in his day. From a bunch of gypsies he secured a big dark-brown Morgan stallion and another of the Hamiltonian strain, both of which he turned loose on the mesa. For years, high-stepping Hamiltonians and dusky Morgan colts bobbed up in the wake of range mares. But inbreeding and the scarcity of feed have about obliterated every trace of Hamiltonian and Morgan blood. Only old Sabine continues to mark his colts. Old Sabine whose blood was hot and rich!

When Don Panfilo Lavato, after 50 years of ranching, decided he had had enough, his layout was just what Shorty Liston wanted. In 1928 they made a dicker, in which Shorty took over the property, together with all the stock. The ranch consisted of 250 acres of deeded land, and the stock on the range included all of the horses and cattle wearing the PL brand, together with their increase. Shorty estimated the number of horses he was supposed to get in this deal at about 700. He has spent fifteen years trying to run them down, and still has plenty of work ahead of him.

In addition to the Don Panfilo horses, Shorty bought another herd from a San Felipe Indian named Juan de Dios Ten-

MRS. LISTON AND AN OFFSPRING OF OLD SABINE

The wife of Shorty Liston, wild-horse wrangler, poses with a pinto pony that bears the markings of a famous red-roan stallion that roamed the range 50 years ago. The animal shown was eight years old when it was captured and domesticated.

orio. "Chief," Shorty said to John of God, "how about me buying that bunch of caballos you've got out there on the mesa? You can never catch 'em yourself." "OK amigo Shorty," answered Juan de Dios, "how much?" The upshot of the matter was that Shorty became the owner after a palaver that probably took all summer. And he estimated that he got title to about 400 head in the deal. Shorty is still trying to take delivery of this herd, as well.

Shorty Liston's own brand is a lazy TX on the right shoulder. Figure that out, a lazy TX! Juan de Dios Tenorio marked his horses with the figure eleven. This brand belongs to all the San Felipe Indians, but each has some pet place on the animal to put it. The same applies to the Indians of Santa Ana, who use an X with the bottom closed; the Indians of Santo Domingo whose brand is SE; and the Zia Indians who have the lightning brand. In addition to the foregoing, the old Baca brand, that looks something like a weather vane, still bobs up on the mesa. And don't forget, there are caballos running the range that are old enough to have false teeth and that wear neither man's brand—nor his collar!

To the average man the name wild horse always brings to mind the image of a snorting charger standing high on a hilltop with his mane and tail flying in the breeze. There he stands, the picture of grace and beauty. Well, one would have a hard time finding a creature of this kind on Shorty Liston's range today. The blood of the Hamiltonian and Morgan chargers has run pretty thin with the passing years, and only occasionally does the strain of old Sabine leap out from the marking on a wild colt. Most of the horses on the Santa Ana Mesa are runty, broom-tailed mares and knobby-kneed stallions weighing about 700 pounds. In color they run to bays and duns and browns, with now and then a pinto or flashy colored animal that has a hard time staying free because he attracts so much attention. Once in a while Shorty rounds up a horse that makes a good saddle nag. One such horse he called Cry Baby because he bawled at the top of his voice when they were breaking him. Cry Baby was a sun-fishing son-of-a-gun, and even attended a rodeo or two as a bucker, but eventually he took a liking to Gene who made a topnotch roping and riding horse out of him. Another was a pinto that ran the range until he was eight years old before he was caught, and Gene also made a riding horse out of him. Then there was Bess, the fastest thing in Shorty's string. But the prize of the Santa Ana Mesa, according to both Shorty and Gene, was a white stallion which never felt the touch of a saddle on his back. Gene called him Santa Ana.

Santa Ana was everything a wild horse is supposed to be in story books. He led his harem of mares all over the mesa, keeping them out of traps while Shorty and Gene were eating their hearts out trying to get a rope on him. Off and on for three or four years they kept on the trail of Santa Ana, but never got near him. Then came a day! Shorty had built a good stout fence around a water hole where he expected to trap a bunch of wild horses when they came there for their nightly drink. The well-hidden entrance was fixed so that a gate could be quickly slammed shut, corralling the animals. Safely hidden in the brush was Gene, waiting for the herd to come down the trail and walk into the trap. For several hours she was on the alert, and had almost fallen asleep when she heard horses coming. Leading them was Santa Ana, high-headed, wary, and wise to the hunter's tricks. Well, Gene just about stopped breathing! Here was her prize, almost ready to be taken. For more than an hour old Santa Ana shied around that water hole while Gene lay in the brush with her heart thumping. Back and forth he went, trying to convince himself that all was well. Finally, after Gene was practically a total wreck, Santa Ana led his mares into the trap and started to drink. Before anyone could say "Holy Moses," she had slammed the gate shut on them.

Back to the ranch went Gene stepping high, wide, and handsome, and she and Shorty celebrated half the night. They were still walking on air next morning when they returned to the water hole to rope old Santa Ana and to make a domestic animal out of him. But he had other ideas, and lived up to wild-horse tradition by jumping a fence that was too high for any horse to leap over. They never saw him again. He either quit the range or was killed in some manner. But Santa Ana was very much out of the ordinary, and most of the wild horses now found on the mesa are little and runty and worthless.

SHORTY AND GENE

In 1928 Shorty Liston (no one seems to know his first name) bought an adobe ranch house and 250 acres of New Mexico land bordering the Rio Grande River. With them he acquired title to all the horses and cattle on the range that bore a certain brand, together with their increase. He has had a little difficulty taking possession of his hooved property because the animals are wild and the range takes in 20 or 30 square miles of unfenced outdoors. Liston and his wife have spent the intervening fifteen years trying to round up the herd, and estimate that there are still 400 head untethered.

RIDE 'EM COWBOY

Now and then, just to break the monotony of their existence, Liston and his riders stage a rodeo of their own. All they have to do is catch and saddle a few of his wild charges, and the fun is on. Once you mount the hurricane deck of one of these steeds you either ride him or pick yourself out of a cactus bush.

It wouldn't do, however, to get the idea that the nags are docile little lambs, with not enough horsey umph to furnish entertainment. There are times when Shorty Liston and his riders feel the urge to hold a rodeo of their own right out there on one of the black mesas. They don't have to import any stock for the occasion. They've got what they need right on the ground. These shows are not domesticated affairs held behind a big board fence and presided over by a professional announcer hiding behind a loudspeaker. And when Shorty straddles one of the shaggy and unbroken babies out there in the open, it is up to him to ride him, or else. No pick-up men come galloping along to help him off after his time is up. Shorty either sticks on his back 'till the creature is subdued, or else he lands smack in a bed of cactus.

There are lots of ways to catch a wild horse, says Shorty. There have been times when he and Gene decided to run down some particular animal, rope him, and haul him to market. But that method is not only hard on horses but also tough on riders, and more often than otherwise it won't work. The best way according to Shorty's records, which are in his head, is to build a wing chute with a good tight corral at the end. The wings may be constructed along both sides of a narrow ravine or canyon where the horses are accustomed to pass. Along the wing fence are tied pieces of rags to give it the appearance of permanence. The wings may be made of canvas, and even so frail a barrier as a string of binder twine will hold a herd on its course if the riders do not crowd it too hard. When a bunch of horses is started, all the riders work in cahoots to drift the animals toward a natural runway that leads to the wings of the trap. As they go farther and farther down toward the corral, the riders begin to shove them along, and finally they are crowded so hard by every man that they pour into the trap. Once inclosed, the horses are roped, hobbled, and loaded into a regular stock truck to be hauled to market. There was a time when horses were delivered on foot, but in these days where speed is a factor trucks have been found to save both time and money.

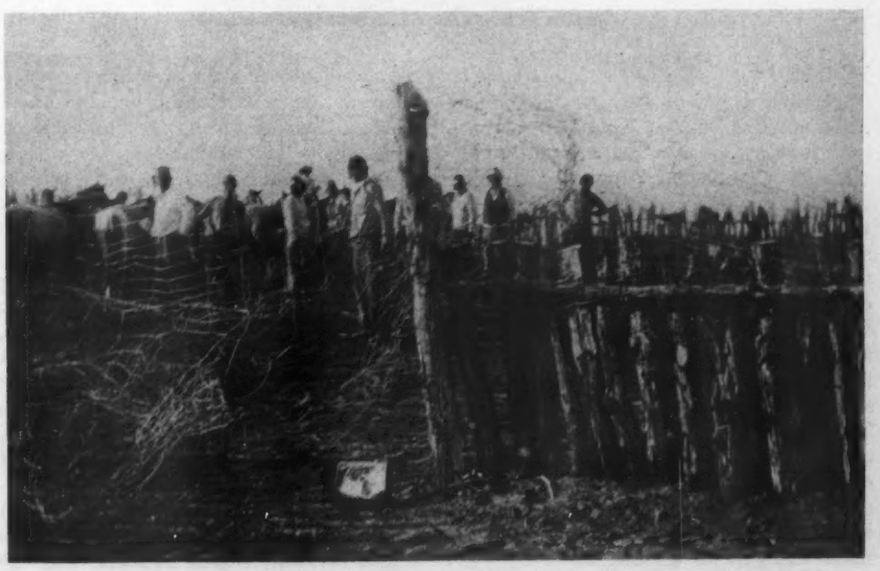
Shorty usually uses four or five men—generally Indian boys from San Felipe or one of the other pueblos—on a horse drive. Gene is perfectly capable of holding down her share of the job, and usually does so. After several drives, it is always necessary to move the trap to another position. Shorty has constructed a moveable corral of woven wire that can be thrown up when and where it is needed. A trap around a natural water hole is one of the best methods of catching wild horses. The work is done at night and involves much less labor because the animals are enticed into it and do not have to be driven for a day or so.

Shorty and Gene Liston have caught more than 1,500 wild horses in the Santa Ana Mesa country during the past fifteen years. They have no way of telling the exact number, nor the amount of money for which they have been sold. Shorty does not keep books! In the early days on the range he got as many as 300 in twelve months. Since the animals have been thinned out, his annual catch has been much less, although he made one drive in 1941 in which 78 were corralled.

Wild-horse hunting on the Santa Ana Mesa is not a very profitable business, states Shorty. The price he gets for the animals is low, ranging from 1 to 1½ cents a pound. As some are yearlings, the average current price per head might run from $5 to $6. In former years he sold many at a flat rate of $2.50 a head. The markets for wild horses in Albuquerque, where nearly all the Santa Ana Mesa stock is sold, are the zoo, where they serve to feed the animals; a packing plant that makes fertilizer, dog food, etc.; and a fox farm, a dog farm, and a fish hatchery. Some of these will contract for a certain number of horses to be delivered at regular intervals. The packing plant uses the largest number.

Hunting wild horses is no job for a sissy. Although Shorty Liston is a little guy, who has been sawed down to about five feet two, he is hard as nails. In the course of his business he has been busted into pieces and tied together with baling wire a time or two, but he was never sent to the hospital until some kind of a germ laid him low for a year and a half. On one occasion his horse fell with him going downhill, with the result that the horse's neck was broken and Shorty's ribs were torn loose from his breast. Besides that he has had a broken shoulder, more broken ribs, and five joints of his spine have been twisted.

Wild horses still roam the range within 25 miles of the largest city in New Mexico. They are not so numerous as they once were, but Shorty Liston and his wife Gene are still out there doing their best to round up the remainder of the ones they bought from Don Panfilo Lavato and Juan de Dios Tenorio. And every once in a while they drag in a colt that shows the marks of a certain red-roan stallion which has been dust these many years. Pretty strong character, old Sabine!

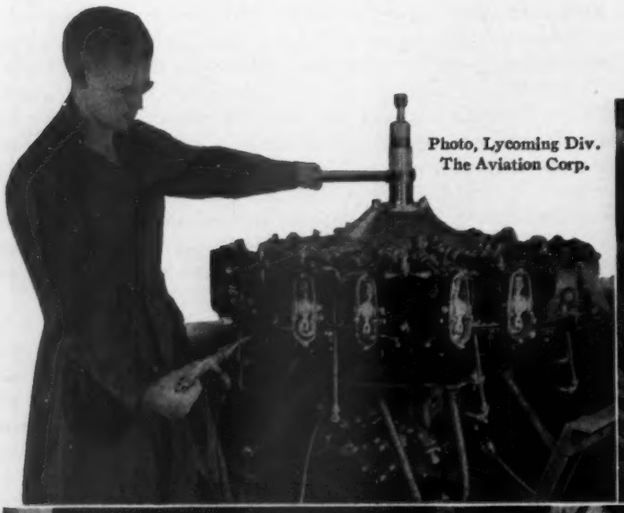


INDIAN HORSE HUNTERS

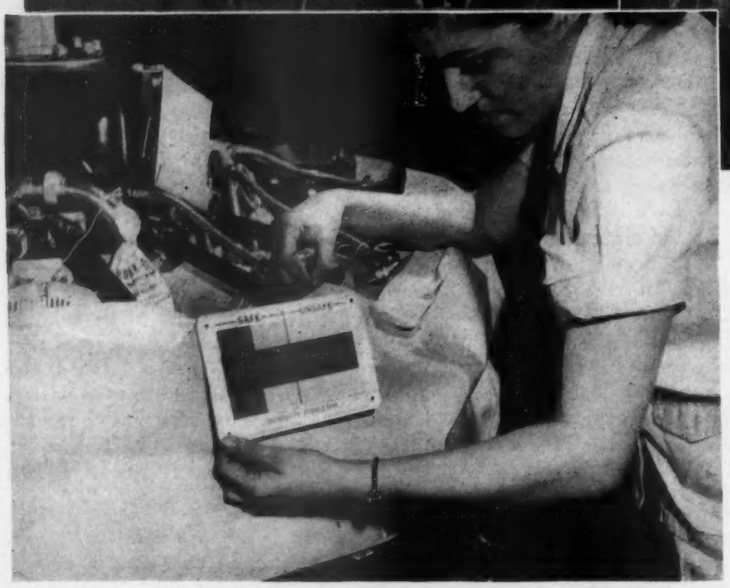
The technique of catching wild mustangs consists of building a strong stockade of timber and wire, with wing fences leading to its single entrance. Then you mount horses and attempt to drive the quarry into the enclosure. Sometimes it is quite a trick to accomplish this. Liston uses the neighboring San Felipe Indians to help him perform this chore.

Antirust Insurance for Airplane Engines

A. M. Hoffmann



Photo, Lycoming Div.
The Aviation Corp.



Photos, Wright Aeronautical Corp.

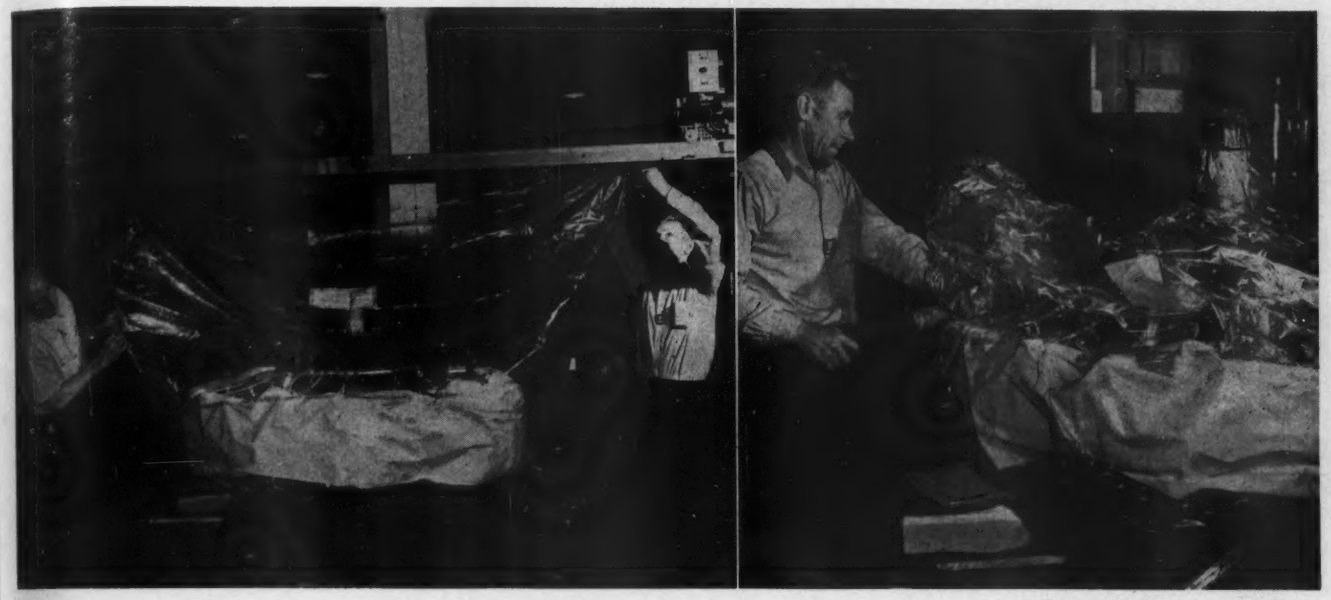
SAFEGUARDS AGAINST CORROSION

The operator at the top, left, is spraying a rust preventive into an airplane engine through the spark-plug holes. With his left hand he is turning the crankcase to distribute the liquid thoroughly. The engine shown above has been flushed with hot oil and washed in Varsol—a noninflammable solvent—and is being further protected against corrosion by the application of silica gel in crystal form packed in perforated cartridges and bags. The girl has an armful of the latter and is placing one on top of each cylinder, while the man is inserting a cartridge into the oil sump. A smaller one is also screwed into each spark plug to absorb the moisture inside the cylinders. The crystals are deep blue when dry and pink when saturated, the change in color indicating the degree of absorption. Visible evidence of this is given by a humidity indicator (left) that is packed with each machine.

BECAUSE of what is happening in the theaters of war, the public need not be told that United States aircraft in ever-increasing numbers are fighting on foreign shores. However, it might be of interest to learn something about the precautions that are being taken by shippers to guarantee that those planes will reach their destinations in first-class condition to take off as soon as they can be assembled. In crossing the oceans by freighter, for all machines cannot be ferried over, there is an enemy other than submarines that must be guarded against. That enemy is moisture, which, through corrosion, can do so much damage to aircraft engines between the time they conclude their test runs and their delivery that it may take many precious days to make them fit for service.

To obviate such delays, there has been worked out an engine-preservation program that is in force today and that had its beginning early in 1939 when Esso Marketers, after consultation with the Navy and leading aircraft manufacturers, began laboratory work on a corrosion preventive that would neutralize the acidic products resulting from the combustion of high antiknock airplane fuels; provide protection against high humidity during protracted storage; have a minimum effect on the various metals and materials that enter into the construction of an engine; have no harmful effect on the lubricating oil; and be nonoxidizing and nongumming in storage. This was a large order; but, judging by what is being done, it has apparently been met. Subsequently, it was decided that, in order to facilitate application, it would be desirable if the preservative could be used as a lubricant for a brief period.

Upon the discovery of a preventive that seemed to meet all the requirements, the armed services, engine builders, and the Aeronautical Materials Standards Subcommittee of the Society of Automotive Engineers undertook to investigate the matter, with the result that a 3-point program of engine protection was adopted. This involves the use of rust-prevention materials; placing a dehydrating agent in and around each engine; and wrapping it in a moistureproof container. The application of the preventives is effected variously and takes place as soon as possible after the break-in or test run when conditions already are such as to cause corrosion, especially in the cylinders. These are coated by introducing a quantity of the solution into the fuel-induction system just before the engine is stopped and the moisture present has a chance to condense. It is said that one pint of Rust-Ban 604 for every 1,000 cubic inches of piston displacement is sufficient to cover the cylinder walls, pistons, and valve heads. In addition, the coating is sprayed into each cylinder through the spark-plug openings, the engine being cranked the while by hand to make sure that this supplementary film is spread over every square inch of the respective parts. Other interior surfaces are treated in different ways. In the case of the quickest and most effective of these the preventive is applied by using it as a lubricant for the engine during the last



Photos, Wright Aeronautical Corp.

AIRTIGHT SHROUD

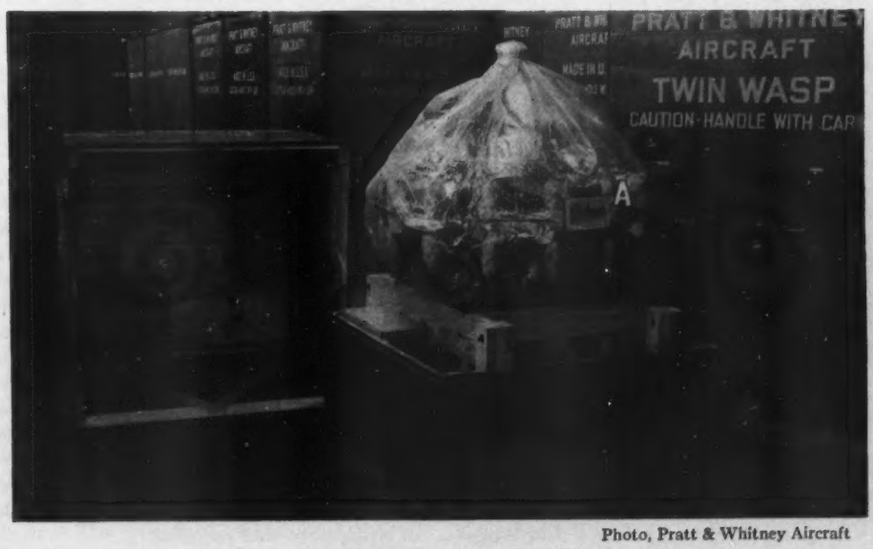
The picture at the left shows a Cyclone aircraft engine with a strip of oilcloth over the cylinders to protect the Pliofilm envelope from contact with sharp surfaces. After the machine is lowered into the bag, men pull the open edges taut in an overhead rack, where they are vulcanized by an electrically driven heating unit that travels the length of the rack. A small opening is left in the envelope so that the moisture-laden air within can be exhausted by a vacuum pump, as seen at the right. The suction-hose opening is sealed as soon as the bag has been collapsed.

15 to 30 minutes of its test run. Valve mechanisms, thrust bearings, and accessory drives are reached by air spray.

With the interior taken care of, the exterior is protected by means of silica gel, a pure silicon oxide that can absorb as much as 40 per cent of its weight in moisture. This material is chemically treated so that it gradually changes in color from blue to pink under the influence of moisture, the shade indicating the percentage of absorption. It is packed in cotton bags, and one of these is suspended from each cylinder. In addition, a transparent plastic plug with small perforations in the base and containing silica gel is screwed into each spark-plug opening to take care of moisture inside the cylinders. So safeguarded, the engine is encased in a Pliofilm bag that is impervious to moisture. As a further precaution, some factories exhaust the air from the envelope by means of a vacuum pump before sealing. Triply insured in this manner against corrosion, the engine is ready to be boxed for shipment.

In this connection it is interesting to mention that Pratt & Whitney Aircraft has designed a packing case that, by eliminating protruding hardware, makes it possible to save as much as 500 tons of steel annually, and, what is equally important, valuable shipping space. In place of the usual steel strapping and lifting eyes bolted on the outside, the box is provided with two thin metal bands and countersunk handles. This substitution has resulted in such a reduction in over-all dimensions that a regulation freight car which formerly had room for only ten machines of a given size can now take twenty. Furthermore, through simplification of the design, the number of basic packing cases for the different types of engines manufactured by the company has been cut from eight to four.

Upon reaching its destination, the moisture condition of an engine can be determined without difficulty by a humidity indicator that is suspended in the Pliofilm bag where it can be observed from the outside. It consists of a graduated color card that contains crystals of silica gel. When the color of the latter is within the blue range on the left side of the chart, the inspector knows that everything is in order; but when it is pink, the engine cannot be released for its exacting service until cylinder walls, piston rings, valve faces and seats, cam plates, wrist pins, gears, journals—in fact, all interior parts and exterior surfaces have been carefully examined. Nothing is left to chance, so that our planes and our boys, who take them aloft in combat with our enemies, will not be endangered by a common enemy—moisture.



Photo, Pratt & Whitney Aircraft

SAVES SHIPPING SPACE

The new smooth-walled packing case with the engine in position. The carton in the left-hand corner of the lid contains the carburetor, while other accessory parts are in the lower half of the box alongside the engine. A hinged port in the side of the packing case enables an inspector to see the humidity indicator, "A," to determine the moisture condition inside the Pliofilm envelope.

SIUNA SCENES

Until recently, all mining operations were conducted in open pits, one of which is shown below. In the foreground, a Bucyrus-Erie 20-B shovel is loading waste into an Autocar 10-ton diesel truck. The view at the left shows the ore-treatment mill. The timber headframe that is used for the shaft-sinking work now in progress appears at the right. A typical crew of shaft workers ready to go underground is shown at the far right.

Tropical Mine Shaft

W. J. Roberts

IN THE heart of Nicaragua's deepest jungles, La Luz Mines Limited is engaged in the production of gold and is sinking a new shaft under rather interesting and unusual circumstances. The site of the property and the available labor and materials combine to create a situation that is common to Central America but differs greatly from similar work in the United States. The operations are located at Siuna in the northeastern part of the country and about 95 miles from the Atlantic Coast. The mine area is characterized by rather sharply rolling hills reaching an elevation of approximately 1,000 feet. To the east lie the savannahs and the lowland jungles, and to the west is the great Rain Forest, terminating in the Cordilleran Range. The climate is subtropical, having a wet season, with a fall of some 80 inches of rain, and a dry season lasting about five months during late winter and spring. The temperature is generally somewhat cooler than at the coasts, ranging from 50° F. on a cool night to 85° or 90° on a hot day.

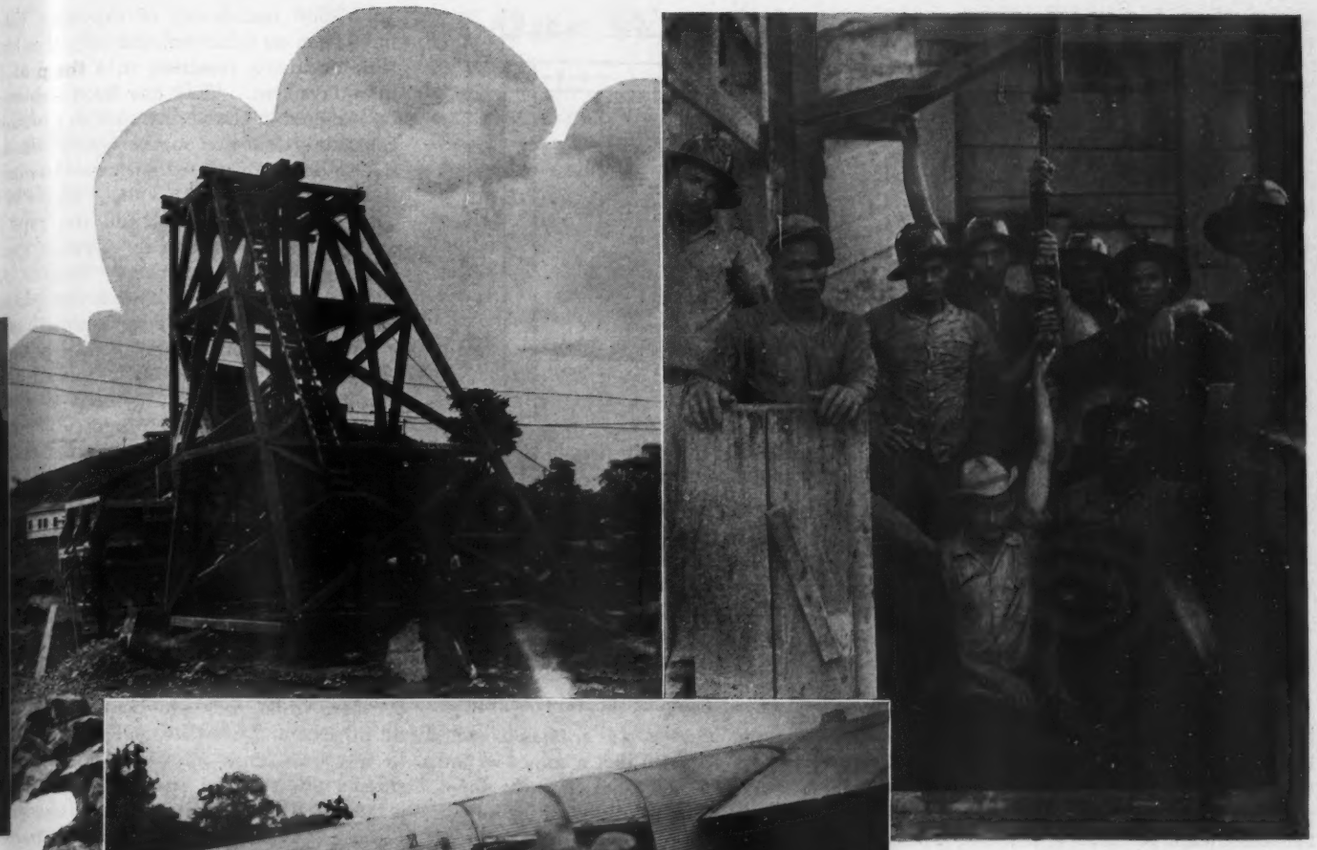
Gold was first discovered in Nicaragua during the latter part of the nineteenth century in small rich placers in Siuna Creek. Later, gold ore was found "at grass roots," and Senor Jose Aramburu of Bluefields, Nicaragua, organized the Compania Minera La Luz y Los Angeles in 1896 under the laws of the republic. In 1905 a group of Pittsburgh men headed by Thomas B. Ritter purchased the company and continued to operate the property. It became an American concern in 1916 when La Luz & Los Angeles Mining Company was incorporated under the laws of the State of Delaware. In 1936 an option was obtained by Ventures Limited and the Tonopah Mining Company, and two years later, when it was taken up, La Luz Mines Limited, a subsidiary, was incorporated. Immediately there was launched a vigorous prospecting campaign of shafts, crosscuts, drifts, raises, and diamond drill holes, and these indicated an ore body 1,200 feet long, 80 feet wide, and continuing to a depth of at least 500 feet.

Siuna is 95 miles by air from the Atlantic Coast port of Puerto Cabezas and 40 miles from the nearest easily navigable river. The intervening country is mostly dense tropical jungle, making transportation a major problem. The early companies brought their freight up the Prinzapolka River by *pitpan* (dugout) to a point 7 miles from Siuna, and then through the jungle by pack bulls and women carriers. Naturally, the cost was enormous. Strangely, the women did the freighting for $2 a ton-mile, as against $4 for the bulls. At present it is transported by diesel tug and barge to Alamicamba, the river port, and thence by plane to Siuna. During the last fiscal year there was flown in the huge amount of 14,000,000 pounds of equipment and supplies.

The early operators mined the ore in open cuts, and that system was continued by the present company until increasing depth necessitated a gradual changeover to underground mining. A shaft site was chosen on the hanging wall about 600 feet from the ore body, and work on it was begun in October, 1941. It is of the Kerr-Addison type, and provides for two counterbalanced skip compartments in one end, a large service-cage compartment in the center, and pipe, manway, and cage-counterweight compartments in the other end.

Working through topsoil, the shaft reached well-weathered rock at a depth of 15 feet. According to the late Dr. Forrest A. Kerr, who made a study of the geology of La Luz Mines in 1938, the shaft traverses sediments of Jurassic or Triassic age. The dip of the bedding planes is vertical and the strike is parallel to the long axis of the shaft. The rock drills and breaks well, and also stands sufficiently well to preclude the use of lagging throughout three-fourths of the length. At the 60-foot horizon the rock became solid. Hardwood bearers were then concreted in place, and a concrete ring was poured around the collar. Sinking was resumed from there and continued to the 350-foot level, where the first station was cut. The second station was excavated at the 500-foot level. At this point was encountered the first bad ground in the form of sheared argillaceous rock which necessitated cribbing around the shaft lagging. At the present time the skip pocket for the 500-foot level is being cut.

The first task confronting the American shift bosses was that of training shaftmen. Local labor is made up of three general types: Spaniards from the interior and the



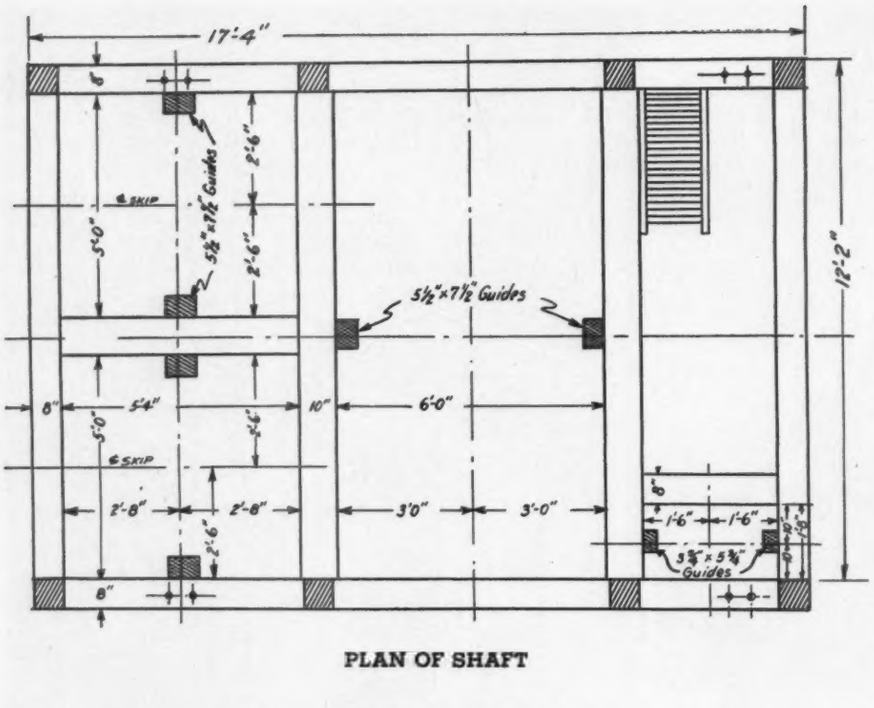
UNLOADING SHAFT TIMBERS
Although the area abounds with softwood timber, the wood rots rapidly in the tropical climate, so long-leaf pine is prepared at a sawmill erected by the company in the savannah country and is flown 40 miles to the mine site (left).

Pacific Coast, Negroes from the Atlantic seaboard and the Caribbean Islands, and Miskito Indians from the Atlantic Coast. The Spaniards vary in degree from white to Indian, while the Negroes are mixtures of negro, white, and Indian blood, with negro predominating. The third, the Miskito, generally ranks below the Spaniard and the Negro physically. From these groups we selected the most active specimens and trained them to run Jackhamer drills, to timber tightly and accurately, and, most important of all, schooled them in the vigorous use of the No. 2 roundpoint shovel. Possibly one man out of every ten had previously had experience in other mines in Nicaragua in drilling and timbering.

Owing to the specialized nature of shaftwork, we get the best results with those that have never seen a mine before, as there is a tendency for a Nicaraguan who has learned one kind of work to revert to it at the slightest provocation. An excellent example of this was observed at a neighboring mine in which was employed a Nicaraguan shift boss accustomed only to drifting. He was put in a stope to direct miners that were drilling a large sideswipe with a raise as the relief point. When the American shift boss came around at blasting time, the whole breast was drilled in one gigantic hammer cut. The latter remarked that he was glad the Nicaraguan boss hadn't worked in a pyramid-cut drift prior to the stoping for the resultant round would have made mining history.

Operations are carried on in three 8-hour shifts per day, seven days a week. Because it is not a working shaft, blasting can be done at any hour and the hoist can be utilized exclusively for sinking. Each shift has a Nicaraguan *capataz* or lead man, seven miners, a top man, and a hoist man. The standard round, determined from experiment, numbers 46 holes each 6 feet deep. Drilling is done with three Ingersoll-Rand JB-5 Jackhamers using ⅞-inch hexagon steel and Jackbits. The starting gauge of the bits is 1⅞ inches, and ⅛-inch changes are usually made. It takes four hours to drill the round. This is good time, and is largely attributable to the ease of handling of the JB-5, which admirably suits the Nicaraguan miners with their slight physique. Atlas electric detonators are employed in delays up to No. 6. The powder, DuPont Gelex No. 2 in 1⅛x8-inch sticks, is loaded ten sticks per hole. The round is wired in two parallel series of 23 holes each and fired with 220-volt alternating current. During one 5-month period no missed holes were discovered.

Broken rock is shoveled by hand into 1-ton buckets, two of which are in service. The average round totals about 180 buckets, and even though the crews have mucked as many as 85 in one shift, the average time required to clean up a round is 28 hours. When in solid rock, the shaft is sunk up to 50 feet in advance of timbering, whereupon sinking is stopped and timbering carried to within 15 feet of the bottom. Plumb bobs are hung in each of



PLAN OF SHAFT

the four corners, and the men try to block the sets within a limit of error of ⅛ inch. As many as two complete sets per shift have been hung and blocked, but the dead work of erecting ladders, pipes, guides, and bulkheads cuts the average to one set per timbering shift. Blasting logs are hung beneath the last set to save the timber. A blasting set was considered, but there was no material available for a metal one, and the hoist is not powerful enough to handle a set made of reinforced wood.

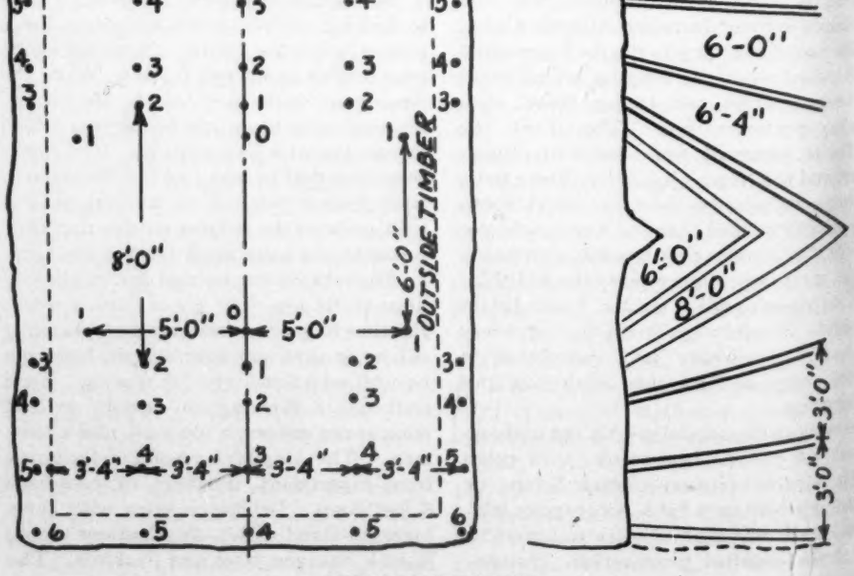
The timber found in the region is principally lechemaria, santa maria, mahogany, cedar, mora, nispero, and como negro. The two last-named hardwoods would make good shaft timber, being almost termite and rotproof, but the trees are not very plentiful and the local sawmill experiences difficulty in cutting the wood. Softwoods rot rapidly in the tropical climate. Therefore the company decided to use long-leaf pine from the savannah country. This is cut at the company sawmill at Alamicamba and flown the 40 miles to Siuna. The timber is framed by hand at the shaft collar by two carpenters who are paid on a piecerate scale. One man can frame a set in four days.

All drilling, mucking, and timbering are paid for on a piecework basis. It has been found that a good piecework scale that will allow a man to earn twice as much as when paid by the day, will result in three times the output. Thus the margin between earnings by the day and by piecework is much greater here than it is in the United States. However, in the States there is a high performance standard for day-pay miners that sometimes approaches 90 per cent of a man's maximum production. In such cases piecework is not always advantageous to a company. When drilling, a miner is paid for each foot of hole that he puts down, but he has to split equally with his helper. Mucking is paid for by the buckets per shift, the amount being divided equally among the crew members. The pay for timbering is at a definite rate per set and is divided equally among the gang. This system has resulted in each individual doing his best work, whereas if the pay were based on a footage-of-shaft-completed basis there would be a strong tendency to "let George do it."

The accident record has been very good. In 57,000 man-hours of exposure there have been no fatalities, and only five lost-time accidents resulting in a total of 27 man-days lost. This has been achieved by reasonably close adherence to practices commonly followed in the United States. Safety doors are closed whenever material is loaded into the buckets. There is a weekly rope inspection, and the rope is changed when the wear appears great enough to affect the safety factor. At occasional intervals bulkheads are placed in the shaft, leaving only a small hole in the center compartment for the passage of the sinking bucket. All employees are required to wear safety helmets.

The air supply for the property is taken care of by an Ingersoll-Rand PRE 2-stage, 2,200-cfm. compressor, with four Type 40 air-cooled units serving as stand-bys. For small jobs away from the central plant are used three portable compressors—two Mobil-Airs and one 600A machine. X-71 wagon-mounted drills do the primary drilling in the pit, while secondary drilling is done with S-49 Jackhamers. Bits are reground in the steel shop on a J3 Jackbit grinder, while rods are heated in a 7F oil furnace and are threaded and shanked in a 45SP shank and bit punch. The shanks are squared up in a 4K shank grinder. Also in daily use are Ingersoll-Rand Stopehamers, Tugger hoists, pneumatic drills, chipping hammers, riveting guns, and Cameron sinking pumps.

The writer is indebted to Frank Cameron, general manager of La Luz Mines, for his generous aid in furnishing information for this article, and also to the July 3, 1920, issue of *Engineering and Mining Journal* for the early history of the mine. C. J. Nelson is the mine superintendent.



THE DRILL ROUND

Log of Our War Economy

THE following paragraphs contain significant bits of information culled from official press releases sent out by the War Production Board.

NOVEMBER 27—Donald M. Nelson approved a general holiday for all war-plant workers on Christmas day, stating that "more than ever before in our lives we need this year to pause from our labors and think deeply and humbly about the faith by which we live."

Restrictions on the use of zinc were tightened because of the critical shortage of this metal, which is used in cartridge brass, ship propellers, guns, tanks, and many other essential military items.

NOVEMBER 28—In line with its new policy of curtailing uses of essential materials for construction projects, WPB stopped work on a $45,000,000 expansion program for the Continental Ordnance Plant at Hammond, Ind. It was stated that the work could not be completed in time to justify the large expenditure of critical materials.

A glass company was ordered to reemploy seven members of a religious cult that were dismissed for refusal to participate in a flag-raising ceremony. Other employees were cautioned against molesting the reinstated men. The basis of the order was the constitutional guarantee of equality of rights and opportunities to all persons, regardless of creed.

DECEMBER 3—Although the normal operating season closed on November 30, Great Lakes ore vessels were continuing to run, and it was assured that they would transport 91,500,000 tons of ore during the 1942 season and thus exceed the goal set by WPB. All records for a year and for a single month have been broken, and sufficient ore has been delivered to enable the expanded steel mills to maintain their schedules.

DECEMBER 6—Our 1942 production of vital war equipment was given as: 49,000 airplanes, 32,000 tanks and self-propelled artillery, 17,000 antiaircraft guns larger than 20 mm., and 8,200,000 tons of merchant shipping. The total number of persons in war work has risen from 7,000,000 to 17,500,000. Our transportation systems carried the greatest volume of traffic in history. Food production reached a new high during the year. Our expenditures for munitions and war construction will exceed $50,000,000,000 for the year. Total taxes paid will approximate $13,000,000,000. In addition, the people advanced $33,000,000,000 for war purposes through purchases of bonds.

DECEMBER 9—With 36,621,000 men employed in industrial plants during the first ten months of 1942, the man-days of idleness amounted to only 28 per cent of the average for the last five years of peace. Since the Pearl Harbor attack, the time lost in war industries because of strikes has never risen above one-tenth of one per cent of the man-days worked.

DECEMBER 10—The manufacture of 300 semitrailer petroleum tank vehicles, each holding 4,000 gallons of oil, has been authorized. It is planned to use them for short-haul distribution of petroleum in the Mid-West, thereby releasing 1,500 railroad tank cars for long-haul service to the East. The new vehicles will transport more oil per pound of steel and rubber than any other type in use and also require less manpower.

Expenditures for war aggregated $46,075,000,000 during the first eleven months of the year. For November they totaled $6,112,000,000, an average of $244,500,000 a day and exceeding October by 6.8 per cent.

DECEMBER 11—New housing accommodations are being constructed in mining areas of six western states to take care of additional workers needed to increase the output of copper, zinc, molybdenum, and tungsten. Recently, 4,000 men with mining experience have been released from the armed services to bolster production, and it is estimated that 2,500 more workers will be required to fill labor quotas.

DECEMBER 12—Because of the growing dependence of the public upon street cars and trolley buses, the 1943 allotment of repair parts and materials for their maintenance is greater than the 1942 quota. These carriers will be permitted to acquire new parts in amounts proportionate to the growth in their volume of service. Parts may not be replaced so long as they can be safely used, and discarded parts must be disposed of for scrap within 30 days.

DECEMBER 15—A Combined Steel Committee of seven members has been formed to pool the iron and steel resources of the United States, the United Kingdom, and the Dominion of Canada. The steel production and munitions-making facilities of the three nations will be considered as a single unit to the end that the maximum impact of weapons of war may be brought to bear against the enemy. The first work of the body will be to assemble information on the iron and steel output and to study means of increasing it and of improving its distribution and use.

The point rationing system will be introduced in the United States early in 1943. Books will contain coupons of different denominations, and the various commodities purchased will call for varying numbers of points. For instance, eight points may be required to buy a pound of tenderloin steak and only one point to buy a pound of hamburger steak. This example is for purposes of illustration only, as no values have yet been assigned to the points.

Joseph B. Eastman, director of defense transportation, urged that all 1943 conventions be canceled unless they will contribute in an important way to the winning of the war.

DECEMBER 16—Paul V. McNutt, chairman of the War Manpower Commission, stated that the public is apparently still largely unaware of the great need of war workers. This is indicated by the low enrollment in the preëmployment Vocational-Training-for-War-Production courses. Approximately 160,000 persons are availing themselves of them, whereas, Mr. McNutt says, from 320,000 to 500,000 should be getting instruction. Most prospective workers prefer to get a job first and learn afterward.

DECEMBER 17—During the past year, 6,473,855 pounds of scrap was collected in the national parks of the country. Yosemite Park, California, led with more than 500,000 pounds.

The Office of War Information has contracted with a private publishing company to issue a bimonthly magazine called *Victory* for distribution abroad. It will be printed in several languages, and is intended to counteract enemy propaganda. Its advertising pages will enable American industry to tell the world how the nation is geared for the war effort.

Proposals for simplification of women's hosiery are being studied. It is hoped that they will help solve the problems of diminished skilled labor and shortages of cotton and rayon in that industry.

DECEMBER 19—James C. Woodson, former vice-president of the Lee Wilson Engineering Company, has been named "Industry Advocate" by the WPB. Industrial executives who feel that they cannot answer questionnaires sent them by the WPB are invited to lay their troubles before Mr. Woodson. It will be his duty to balance the need for the requested data against the burden imposed upon business concerns in compiling them. If he finds that the burden is disproportionate to the aid the war program will receive, he will so inform the Office of Survey Standards of the WPB, which has the power to eliminate proposed questionnaire forms.

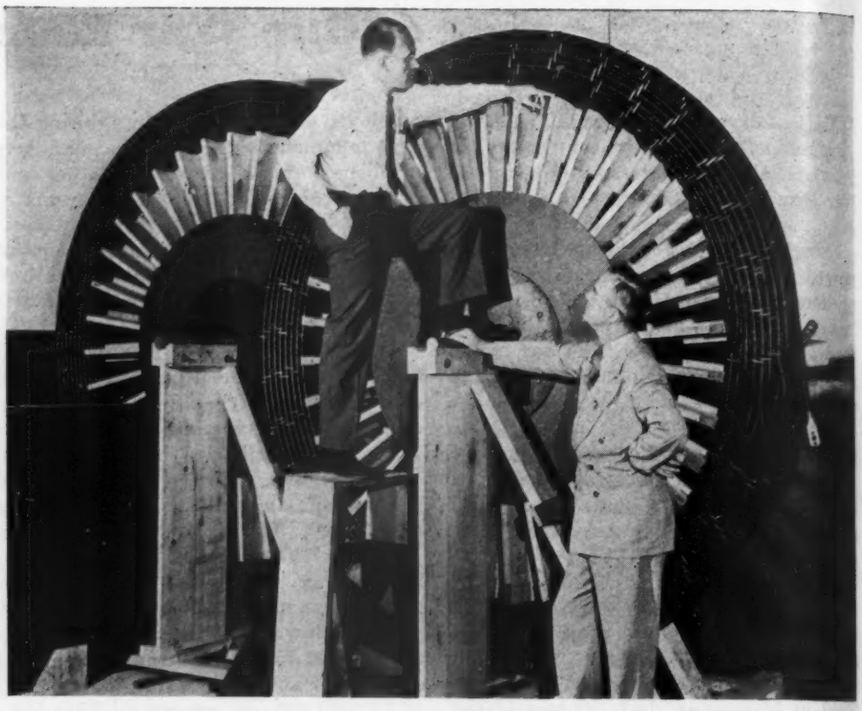
Industrial X-Rays of Greatly Increased Voltage

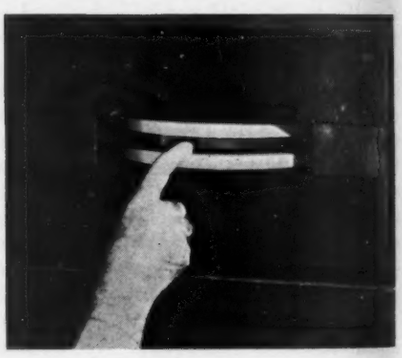
IN A special building with 3-foot concrete walls, General Electric Company is installing a machine that will speed electrons to energies of 100,000,000 volts and produce X-rays of the same power. This is far beyond anything previously produced by human agencies, and will enable scientists to answer, among other things, a question that has been raised in connection with industrial radiography. Eight inches of steel is the practical limit of the present 1,000,000-volt X-ray outfit. What the scientist is going to determine with the "induction electron accelerator" is whether increased voltage will make it possible to examine armor plate or other castings of much thicker cross section. As the unit will produce X-rays of any voltage up to 100,000,000, he expects to find out just what is the maximum useful limit of the X-ray in this work.

The main part of the huge machine is an electromagnet weighing 125 tons. This is constructed of more than 100,000 pieces of silicon steel, each 0.014 inch thick, because the use of alternating current prevented making it solid. At the heart of the magnet, between the 78-inch-diameter pole faces where the magnetic field will be most intense, is a vacuum tube 6 feet long, 5 inches high, and 8 inches across made by the Corning Glass Works of twelve ¼-inch-thick molded sectors. Inside the tube the electrons will be whirled around 250,000 times in 1/240 second, receiving a 400-volt push each trip. In that interval they will travel about 800 miles, which, quoting Dr. E. E. Charlton, head of the X-ray section of the General Electric Laboratory, "is like shooting on a curve for a distance as great as from Schenectady to Chicago and hitting a 3-inch target."

The operation of the electron accelerator is similar to that of a transformer used for changing the voltage of alternating current. The latter consists essentially of a primary and of a secondary coil wound around a steel core. Current at one voltage is passed through the primary and comes out of the secondary coil at a different voltage, even though there is no direct connection between them. For example, if the secondary has twice as many turns of wire as the primary, then the final voltage is twice as great, and *vice versa*. In the case of the accelerator, two 98-inch coils constitute the primary and the interior of the vacuum tube between the magnetic poles the secondary coil.

Starting from an "electron gun" containing an electrically heated filament like that of a small incandescent lamp, the electrons are speeded up during the first quarter of each cycle of the alternating current, which changes 60 times each second. At the end of the quarter the electrons strike a target and generate a beam of highly penetrating X-rays which emerge from the machine, together with scattered electrons. Even the latter are capable of penetrating approximately 2 inches of steel. It is for protection against them, as well as the X-rays, that the walls of the building are 3 feet thick. The control room is outside the structure where the operations can be watched with safety by the aid of a periscope. Above that room is the largest single bank of capacitors—42,000 kva.—in the country.





COILS AND MODEL

Above are the two 98-inch coils of the 100,000,000-volt induction electron accelerator designed by Dr. E. E. Charlton and W. F. Westendorp, right and left, respectively. Each coil has 40 turns of insulated copper conductor 0.88 inch in diameter and contains 1 ton of metal. A model of the machine is at the right, showing the electromagnet interposed between the coils.

The 100,000,000-volt electron accelerator is the second one built by the General Electric Company. The first one is of 20,000,000 volts and was completed about a year ago with the assistance of Dr. Donald W. Kerst, of the University of Illinois. The unit has been loaned to that institution for use by Doctor Kerst in his experimental work. So far as is known, he is the first to apply successfully the principle on which the machine is based.

Air Lift for Unwatering Underpasses

WALTER B. Cannon of Hollywood, Calif., is an advocate of the air lift for unwatering underpasses where ordinary artificial drainage is inadequate. "In that case," he writes in *Engineering News-Record*, "an air lift is hard to beat for cheapness, reliability, and simplicity. All you need to do the job is a pipe and a portable compressor. I am unable to refer to any design data, as the literature starts at 25 feet and runs down to 2,500 feet. The underpass lift starts at zero when the pass is full and will hardly go over 25 feet as a maximum, but if it does it is easily taken care of. I have seen a 20-foot 10-inch pipe two-thirds submerged deliver 1,000 gpm. with a 200-cfm. compressor.

"The air lift will work at reduced capacity down to one-third submergence, which can be obtained in most underpasses with reasonable-depth sumps. If used much at this depth, however, it would be more desirable to make a small sump installation, thus obtaining the benefit of more submergence. The lift will pump any combination of sand or mud. No elaborate air head is necessary, as an air pipe down the center of the water pipe with perforations at the bottom to break the air into bubbles is all that is needed."

The Giant Awakens

OUT of the welter of news from the home front certain facts are beginning to crystallize, and they are cheering facts. Two of the most stimulating reports come from the automotive industry and from the Aluminum Company of America. Both give evidence of what our gigantic industrial machine can accomplish when it really gets rolling.

A little more than a year ago the automobile industry was still placidly building automobiles. Then came the attack on Pearl Harbor and the call to action from Washington. A few hours before 1941 expired, fifteen leaders of that industry gathered around a table in Detroit and formed the Automotive Council for War Production. They signed a pledge to devote the unlimited efforts and facilities of the industry to the production of war materials and promised that "the nation and her allies shall not lack for one gun, one tank, one plane which the capacity and ingenuity of this industry can produce."

Immediately thereafter things began to hum. Commercial rivalries were forgotten. Brains, brawn, and machinery were pooled in the common cause. A survey disclosed 250,000 machines in 442 plants of 259 companies, and steps were taken to put them all to work. Some had to be reconditioned, others moved to different plants, and all was done as quickly as possible. By April the teamwork was beginning to tell. On July 10, Donald M. Nelson told the industry that it was expected to handle one-sixth of the country's war-production program. This seemed like an amazing assignment, but it was accepted.

By midyear most of the plants had been converted and were going full blast. When the first anniversary of the Pearl Harbor attack rolled around, the industry was turning out as much material in a week as it had been making in a month one year before. Today it is producing at the rate of $20,000,000 worth a day. This represents $7,000,000,000 annually. It is equivalent to manufacturing 10,000,000 cars and trucks a year, whereas the best peacetime output was 5,358,420 units in 1929. All the industry's plants are now engaged in war work, most of them 100 per cent. They are employing 50 per cent more workers than the highest prewar enrollment. Most significant of all is the statement that when the peak is attained, production will be double today's outpouring.

Similar heartening news is contained in the year-end report by Roy A. Hunt, president of the Aluminum Company of America. That concern and others engaged in the business turned out 1,000,000,000 pounds of aluminum in 1942, or 63 per cent more than the 1938 world output. Its current rate of production is greater than that of all the Axis-controlled countries of Europe, and probably eight times that of Japan. In the year to come it will exceed any possible output of all our enemies combined.

Fabricating facilities have kept pace with production. Alcoa now forges 25 times as much aluminum as it did before the conflict, and has multiplied its output of castings by eleven and its extruded shapes and tubing by nine. A single mill is turning out one and one-half times as much high-strength alloy sheet for airplanes as the nation used during the entire year preceding our entry into the war.

These illustrations are typical of the progress other companies have made. Truly, American industrial might is beginning to assert itself.

Wartime Construction

THE construction industry had its biggest year in history in 1942, when it accounted for more than $14,000,000,000 worth of work. All but an insignificant percentage of it was for war purposes. At the time of the Pearl Harbor attack the industry had already been converted 75 per cent to war work, and this trend was accelerated as soon as the nation entered the conflict.

Activities reached their peak in August, when 2,413,000 persons were employed on new construction. Of this total, 1,675,000 were at work on publicly financed undertakings and 738,000 on privately financed contracts. Since August there has been a pronounced decrease, and there will be a further tapering off in 1943. According to estimates of the Associated General Contractors of America, the 1943 construction outlay will be approximately $7,000,000,000, or half that of 1942. Most of this will be for direct war purposes and, until the fighting is over, there will be too few materials and too little manpower to permit much private building.

The U. S. Department of Labor predicts that employment in the construction field will average 1,040,000 persons in 1943, as compared with 1,999,000 in 1942. There will thus be released nearly 1,000,000 workers who will be available for other war activities. For the most part they are highly skilled men, and efforts will be made to transfer them to lines of endeavor where their training will be of value. Many of them will fit naturally into the shipbuilding program, but the number is greater than the industry will require. The shift of so large a force into different channels will be attended by serious problems, and these are now receiving the attention of the Department of Labor.

All in all, the construction industry has done a very creditable job of building as an aid to the war effort. Speed records for various types of structures have been broken and rebroken many times over. Fighting men have been trained, ships and planes built, and huge quantities of weapons and munitions manufactured in new plants that did not exist when the emergency arose two years ago. The work was not confined to the home front. In many parts of the world United Nations' forces are using facilities built for them by America's army of construction men.

Industrial Notes

A new, small air-operated drill manufactured by Ingersoll-Rand Company is said to be finding wide application on the production lines of our war plants, particularly on those building aircraft. Identified as the Size 00A, it has a length of 5⅞ inches and weighs less than 2 pounds. It is powered by a Multi-Vane air motor; has a built-in speed regulator that can be set for any desired performance; and split-second throttle action permits quick, accurate hole-starting. Lubrication is provided by an automatic oiler that is an integral part of the tool. The drill is of sturdy construction for 3-shift work and, because of its lightness and "fit-the-hand" pistol grip, can be used hour after hour without fatigue, making it ideal for women operators. A chuck shield offers protection as well as a grip for the free hand, thus enabling the worker to guide the tool effectively. Detailed information about it can be obtained from Ingersoll-Rand Company, 11 Broadway, New York City, or any of its branch offices.

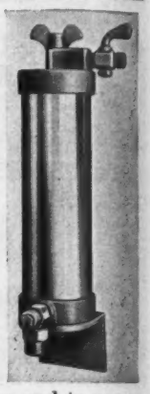
Savings in tin of from 40 to 65 per cent, as well as of electric power and labor, are claimed by E. I. du Pont de Nemours & Company for its new electroplating process. It makes use of a neutral instead of an alkaline solution and prevents the formation of sludge and, consequently, waste of tin. It is also said to give a thinner and a more uniform coat than when strip steel is run through a bath of molten tin and to do the plating twice as fast. Several tinning plants are trying out the process.

Diesel-engined motor trucks in Nigeria may in future be driven with vegetable instead of mineral oil, according to a British press report. Tests made in England showed that engines equipped to take care of heating and filtration ran more quietly and smoothly with peanut, cottonseed, or palm oil than with the regular fuel, but with a slight loss in power. However, mineral oil has to be used for starting because of the viscosity of the vegetable product. The mileage obtained per gallon in a 300-mile test was as follows: mineral oil, 17 miles; palm oil, 15.4 miles; peanut oil, 14.7 miles; and cottonseed oil, 14.5 miles.

To approximate the cost and flying time of air-express shipments, the Air Express Division of the Railway Express Agency, 230 Park Avenue, New York, N.Y., has worked out a simple estimator that shippers can obtain free of charge. It is a pocket-size slide rule with the air routes of the United States and Canada printed on one side. The maps give the mileage and flying time, and the cost is obtained by setting the slide at the figure corresponding to the weight of the consignment.

In a pamphlet entitled *Fend*, the Mine Safety Appliances Company enters into the vital problem of industrial dermatitis and its control and explains the remedial effects of five creams and one lotion which have been introduced under the name of Fend. Each offers protection against specific skin hazards, which are listed in an application chart in the back of the book. The preparations are put up by the same concern that produces Foille, an industrial treatment for burns, and are said to be medically correct, easily applied, and removed with mild soap and warm water. A copy of the bulletin, FA-79, can be obtained from Mine Safety Appliances Company, Braddock, Thomas & Meade Streets, Pittsburgh, Pa.

For satisfactory paint-spray operations, especially those that necessitate frequent color changes, the hose delivering the fluid has to be kept clean. To facilitate this operation, the Paasche Airbrush Company has designed a device that is said to do a thorough job quickly. It consists mainly of a cylinder with connections top and bottom for an air line and the hose to be cleaned. The cylinder is filled with a solvent which is forced down through the hose under the pressure of the air. This is followed by a strong blast of compressed air to dry the hose and to remove any traces of solvent and paint particles. The cleaner is provided with a bracket so it can be attached to the spray booth or elsewhere where it will be handy.



In our September, 1941, issue we described the Rotary Pipe Crawler—a go-devil manufactured by the Corona Sheet Metal Works for cleaning water and other fluid lines varying in inside diameter from

Photo, Compressed Air Institute

INDUSTRIAL CENTIPEDE FEEDS ON AIR

This curious-looking apparatus is an exhaust system in an Ohio war-production plant that turns out aircraft accessories. It is removing dust from various working stations where polishing operations are being done. There are 52 inlets, and these draw in a total volume of 25,000 cfm. of air. At 70°F. and about 14 inches of water-gauge pressure, this amounts to some 14,000 tons of air every 24 hours.

5 to 30 inches. The company has recently announced that it is now making 2-, 2½-, and 3-inch crawlers for the removal of paraffin from crude-oil lines. These have solid Neoprene cores, in contrast to the larger ones which are hollow and are charged first with compressed air and then with water. All are covered with chain mesh.

A temperature indicator in liquid form suitable for glass, wood, ceramics, plastics, as well as metal, has been announced by Tempil Corporation. A thin daub of it applied to the working surface is said to dry instantly and to give warning by liquefying the moment the predetermined temperature has been reached. The smear solidifies upon cooling, leaving a vitreous mark that is easily distinguished from the original one. The product is marketed under the name of Tempilaq and is available for melting points ranging from 125 to 1,600°F. A letter addressed to Dept. D, 132 West 22nd Street, New York City, giving the temperature to be indicated, will bring a sample.

Color is doing its bit in warfare, says the Color Research Laboratory of the Eagle Printing Ink Company. Tanks are painted white inside to repel heat and to give the drivers all possible visibility from the trickle of light that enters; shells of different gauges are marked with varying hues to permit instant identification; and bullets for aerial target practice are stained to leave tell-tale marks by which the accuracy of individual gunners can be determined. In the field of camouflage, the aim is to provide green pigments that will reflect infrared the same as does the green chlorophyll of nature. Green foliage and green paint may appear to be perfectly matched to the eye, but in an infrared photograph taken from an airplane the paint will show up black and white, thus discounting the work of the camouflage artist.

Russian colliery engineers have developed equipment that facilitates the work of shaft sinking, according to *Iron & Coal Trades Review*. It serves the same purpose as a tunnelman's drill carriage in that it makes it possible with one set-up to drive a series of holes in the shaft bottom. Instead of drills, the unit carries pneumatic picks on the lower of two platforms, which are raised and lowered by means of a central pipe that also houses the air-supply line. Radiating from the pipe are adjustable, hinged arms that permit shifting the tools and swinging them up out of the way for hoisting and lowering the carrier. The controls and the operating mechanism are mounted on the top platform, which is provided with three telescoping arms that are forced against the shaft walls to anchor the elevator. The whole outfit weighs 8 tons, and when collapsed for moving measures 5½x8½ feet. During blasting it is raised 164 feet above the shaft bottom. Twenty holes can be put down simultaneously; and it is reported that a total of 307 feet—52 holes—was sunk in a little less than 4½ hours.

With an estimated 80,000,000 tons of bituminous coal in storage throughout the country—twice the usual winter reserve, the risk of loss through spontaneous combustion looms doubly large despite modern methods of storage. As a preventive measure, an exhibitor at the Fifteenth National Exposition of Power and Mechanical Engineering offered a dry-ice treatment. He proposes driving into a coal pile to the danger or hot spot 15-foot, 3-inch pipes with perforated tips and charged with 50 pounds of the solidified carbon dioxide. The heat would liberate the gas, he claims, and thus reduce the local temperature to a point where it would be ineffective. To locate the danger spots he has devised an indicator. This consists of an iron pipe containing a spring-loaded signalling device that is held back by a chain with fusible links at 1-foot intervals. Only the hottest link lets go, and not until the temperature reaches 150°F. At the normal rate of temperature rise in the average coal pile, the location and depth of the hot spot would thus be advertised 72 hours before spontaneous combustion could take place.

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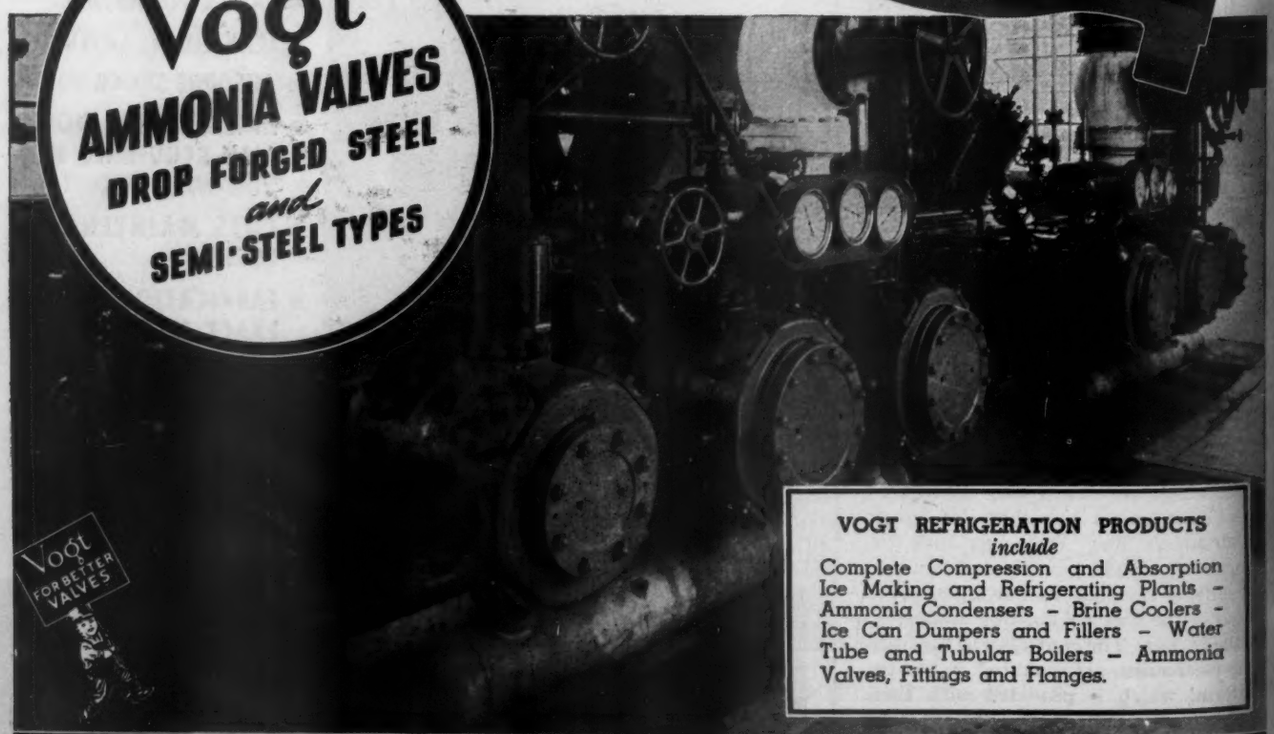

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